A SHORT HISTORY of GEOGRAPHICAL SCIENCE in THE SOVIET UNION

This book presents an outline of the history of geographical science in Russia and the Soviet Union in the form of individual essays. It contains information on the major journeys and expeditions undertaken by Russian geographers, expounds the history of the main geographical institutions in the USSR and describes the principal theoretical advances and practical results achieved by Russian and Soviet geography. The authors mention a large number of the scientists who have played a considerable part in the development of geography in this country and describe the main aspects of their work. This book will be something of a geographical revelation for the foreign reader who is interested in the history of science, but who has no knowledge of the Russian language. It will help him to compound the fragmentary knowledge which he may have of the history of Russian geography and bring to light the deep historical roots from which contemporary Soviet geographical science draws its strength.

Geography section

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A SHORT HISTORY OF GEOGRAPHICAL SCIENCE IN THE SOVIET UNION

UNDER THE GENERAL EDITORSHIP OF ACADEMICIAN INNOKENTY GERASIMOV

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ГЕОГРАФИЧЕСКАЯ НАУКА В СССР
ОЧЕРКИ ИСТОРИИ
Под общей редакцией академика И. П. Герасимова
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INTRODUCTION

THE HISTORICAL ROOTS OF RUSSIAN AND SOVIET GEOGRAPHY

TSAR
My son, what so engrosses you? What's this?

FYODOR
A map of Muscovy; our royal kingdom
From end to end. Look, father,
Moscow's here,
Here Novgorod, there Astrakhan.
The sea there,
Here is the virgin forestland of Perm,
And there Siberia.

TSAR
And what may this be,
A winding pattern tracing?

FYODOR
It's the Volga.

TSAR
How splendid! The delicious fruit of learning!
Thus at a glance as from a cloud to scan
Our whole domain: its boundaries, towns, rivers.

Alexander Pushkin,
"Boris Godunov"

This quotation from the famous work of the great Russian writer, which describes the events of the 16th century and makes reference to a map of Russia (the *Chart of Tsarevich Fyodor*), well known to historians of science, serves as poetical evidence of the origin of Russian geography.

In view of the recently published work by Academician B. Rybakov *Russkiye karty Moskovii* (Russian Maps of Muscovy, 1974), which makes a fundamental study of both the *Chart*'s origin and the *Chart of the Muscovy Lands* of 1479 compiled during the reign of Tsar Ivan III, Soviet scientists have every reason to mark the quincentenary of geographical science in their country.

Maps have for a long time constituted one of the tangible results of geographical research. This was certainly true in the age of great geographical discoveries (15th and

16th centuries), when fairly reliable outlines of the continents appeared for the first time. The *Charts* and other cartographic materials were compiled in Muscovy not just by civil servants, clerks and learned monks, but also by simple Russian people, often anonymous, who by making courageous journeys into the distant parts of the country and the neighbouring territories laid the foundations of Russian geography.

This book presents an outline of the history of geographical science in Russia and the Soviet Union in the form of individual essays. It contains information on the major journeys and expeditions undertaken by Russian geographers, expounds the history of the main geographical institutions in the USSR and describes the principal theoretical advances and practical results achieved by Russian and Soviet geography. The authors mention a large number of the scientists who have played a considerable part in the development of geography in this country and describe the main aspects of their work. This book will be something of a geographical revelation for the foreign reader who is interested in the history of science, but who has no knowledge of the Russian language.

The authors of the book are well-known Soviet specialists working in different fields of geographical science, each of whom has played his part in studying the history of geography. Whilst increasing its overall scientific value, the joint authorship of the work gave rise to a somewhat conventional division of the book into individual essays, which do not correspond completely to the most important stages in the history of geographical science. In specifying the content of the essays priority was given to the authors' principal leanings in research. We therefore thought it advisable to include a short introductory outline containing the most important historical material.

FORMATION OF MUSCOVY. THE ROLE OF THE LAND EXPLORERS IN THE STUDY OF THE COUNTRY'S GEOGRAPHY. ORIGIN OF RUSSIAN GEOGRAPHICAL SCIENCE

Long before geographical expeditions were organised on a scientific basis, major geographical discoveries were made in Russia and the surrounding territories. Driven on by an

unquenchable thirst for knowledge, courageous, energetic people set off at their own risk on long and difficult journeys into the unknown. These people were known as *zemleprokhodtsy*, an old Russian word for land explorers and pioneers.

The *zemleprokhodtsy* began their explorations sowewhere around the end of the 11th century. This activity became known and acquired a great state significance in the latter half of the 15th century and maintained its important role during the 16th century, when Muscovy was formed, and the 17th century, when the latter drew the vast territories of the Far North, Siberia, the Far East and Central Asia into its spheres of interests. Russian people brought back from distant lands a wealth of information on the nature of the countries they had visited, and on their peoples and customs. This information was registered most accurately in what were called *spiski* and *skaski*, that is the stories of these lands recounted by the members of the expeditions, and in the charts—old geographical maps. Among them were the following charts: the *Chart of Muscovy* (late 15th century) and the *Chart of Tsarevich Fyodor* (16th century) mentioned above; the so-called *Great Chart of Muscovy* (last quarter of the 16th century), which covered the vast territory from the mouth of the Neva to the Yenisei; the *Chart of Voyevoda* Pyotr Godunov*, which was the first map to show the whole territory of Siberia known at that time; the numerous charts of the famous Russian cartographer Remizov, such as his most extensive work—the *Book of Charts of Siberia*, which consists of 23 independent maps.

Many of the foreigners who visited Muscovy in those days were extremely interested in Russian geographical material on Siberia, the Far East and Central Asia. This material was used in the West in a great many works of European geographical literature, including various maps, books and atlases, thus reflecting the Europeans' interest in everything which, coming from distant Moscow, represented a source of real knowledge of the mysterious countries of the North and East.

Russian geographical works of the 17th century are, unfortunately, few in number. But together with the incomparably larger number of surviving charts they comprise the

* Voyevoda—the governor of a province.

most valuable stock from which essential materials on the country's geography and cartography were drawn. It is a fact, however, that the maps published in Europe which were based on Russian sources contain numerous inaccuracies and distortions. This is explained by the fact that in those days Russian geographical material was often copied surreptitiously, hastily and sometimes without the knowledge of the persons who entrusted it to foreign visitors. Thus the maps of Muscovy which appeared at the turn of the 16th century were far from being the independent work of the foreign geographers who published them—Herberstein, Gerritsz, Jenkinson, Massa, Witsen—but, as a rule, were imperfect copies of the Russian charts. This makes completely delusory the view currently held in foreign geographical literature that before the foundation of the Russian Academy of Sciences early in the 18th century, Russia was only studied and described by the foreigners who visited the country. As far as geographical knowledge of Central Russia and the newly-discovered lands in Siberia was concerned, foreign authors acted merely as compilers and commentators on the old Russian materials. Moreover, it can be said with certainty that foreigners used only a small fraction of Russian sources. Because their knowledge of Russian geography was second-hand, therefore, the standard of the general conclusions they drew was considerably lower than "that practical, albeit unformed scientific geographical knowledge of Russia which the Russians themselves possessed" (Lebedev, 1949).

STATE REFORMS IN THE REIGN OF PETER I AND THE FOUNDATION OF THE GEOGRAPHICAL DEPARTMENT IN THE RUSSIAN ACADEMY OF SCIENCES

The radical state reforms carried out in Russia at the turn of the 17th century made severe demands on geographical science of the day. More accurate geographical knowledge was required to facilitate the construction of settlements, roads and defence fortifications, and to enable land and sea operations to be carried out. Extensive cartographic work involving the use of astronomical and geodesic methods began at this time in Russia. On the basis of this work vari-

ous geographical materials were collated and the first accurate topographical and geographical maps drawn up. The Russian Academy of Sciences, which was established in 1724, played an important part in these developments.

From its inception the Academy participated in the preparation and organisation of scientific expeditions whose aim was to study little-known territories in the North, the far east of Siberia and in other regions of the Russian State.

Between 1733 and 1743 the Academy helped organise a major multi-purpose expedition known as the *Great Northern Expedition.* The results it yielded were of tremendous significance: it collected a great deal of geographical material on Western and, particularly, Eastern Siberia and Kamchatka, made a voyage to the east from Kamchatka, discovered the north-west coast of America, the Aleutians and the Komandorskiye Islands, charted for the first time the coastline of the Arctic Ocean from the Yamal Peninsula to Cape Bolshoi Baranov east of the river Kolyma, and discovered a sea passage to Japan.

In 1739 the Academy of Sciences' Geographical Department was founded. The French astronomer Joseph Delisle and the famous mathematician Leonhard Euler were invited to Russia as heads of the Department. Together they directed the work on the first *Russian Academic Atlas.* From 1758 the Department was headed by the great Russian scientist Lomonosov, who remained in this post right up to his death in 1765. The Geographical Department, which was the first specialised scientific geographical institution in Russia, played an extremely important role in the development of the country's geographical science. The explorational, geodesic, and cartographical work undertaken by the Department, and its purely academic activities were particularly fruitful from this point of view.

LOMONOSOV'S ROLE IN THE DEVELOPMENT OF RUSSIAN GEOGRAPHICAL SCIENCE

Lomonosov made a tremendous contribution to the development of geography as a science. His scientific views were marked by a materialistic philosophy, progressive attitudes to the cognition of nature, and an understanding of the significance of science for people's lives. His "On the Lay-

ers of the Earth" (1763) may be regarded as a classic in this respect. Here Lomonosov put forward profound ideas on many natural phenomena, which besides being ahead of their time exerted a strong influence on the subsequent development of Russian science.

Lomonosov, for instance, gave a philosophically synoptical opinion of the continuous changeability of nature. He wrote: "...we should remember well that the visible corporal things on the earth and the whole world were not in the same state at the beginning of creation as we find them in now. Great changes have occurred in them, as is shown by history and by comparing ancient geography with the geography of today, and by the changes in the surface of the earth which occur in our times." (M. V. Lomonosov, *Collected Works*, Vol. 5, p. 574 in Russian.)

Directly following this fundamental proposition on the changeability of the world Lomonosov put forward another proposition on the significance of research into the natural causes of phenomena. He came out decisively against teleology advancing a materialistic understanding of causality in nature in opposition to it.

In Lomonosov's view scientific research should serve the purposes of scientific forecast and assist in the rational use of nature's wealth. Lomonosov's conception of the significance of scientific forecast and the practical aims of science is reflected in the very structure of his "On the Layers of the Earth" which begins with a chapter entitled "On the Surface of the Earth" and ends with "On the Use of the Investigating and Discourses on the Layers of the Earth, Especially in Our Country". It is also clearly expressed in his concluding words: "nature herself is waiting for our zeal, which may be rewarded by a great retribution" (op. cit., p. 631).

These extracts from Lomonosov's work demonstrate the great originality and progressive nature of his scientific thinking. As will be shown later, his precepts on the need for a historical, dialectical and integral approach to the study of the surrounding world were preserved and taken as a basis for developing Russian scientific thought as applied to the field of geography.

CIRCUMNAVIGATIONS OF THE GLOBE AND IMPORTANT DISCOVERIES MADE BY RUSSIAN GEOGRAPHERS

In view of the broadening state interests of the Russian Empire a number of major circumnavigations by Russian scientists were organised in the first half of the 19th century. These voyages resulted in a great many geographical discoveries: the circumnavigation of Kruzenshtern and Lisyansky, like that of Golovnin and Kotsebu, provided rich, new material on the science of oceanography; the expeditions of Bellinsgauzen and Lazarev, in which they discovered the Antarctic, and that of Litke along the coast of Asia became famous throughout the world. As a result of these voyages hitherto uncharted islands, straits, capes and bays appeared on the map for the first time with Russian names. In addition to these circumnavigations the first half of the 19th century saw an intensive study of inland seas and coastal waters. The voluminous geographical materials on the European Russia, Siberia and the Russian Far East obtained as a result of academic expeditions in the latter half of the 18th century were supplemented by information on adjacent seas in the early 19th century.

So it was that in a comparatively short space of time Russian geography caught up with the most developed European countries in terms of the wealth of geographical material accumulated. The theoretical side of Russian geography also boasted the advanced general scientific conceptions of Lomonosov and a number of his followers—Lepekhin, Pallas, Krasheninnikov, Falk and others.

GEOGRAPHICAL WORK OF SCIENTIFIC AND PRACTICAL VALUE IN THE 19th CENTURY

In the year 1800 the Geographical Department of the Academy of Sciences was closed down and for many years the country was without an academic centre of geography. This undoubtedly retarded the development of theory in Russian cartographical science. Nevertheless the interests of state demanded that further scientific and practical work be carried out in the field of geography. This concerned first and foremost the study of the country's natural conditions

and resources, as well as the state of its population and economy. Throughout the 19th century various Russian administrative institutions did work on an increasing scale on mineral prospecting, land development and forestry, as well as making statistical surveys of the growth and distribution of the population and economy. This work was concentrated primarily on the provinces of European Russia, which were the most heavily developed and populated. Mineral prospecting was focussed mainly on the Urals, but the Caucasus was also the object of intensive study. This period saw the beginning of systematical topographical surveys and the geographical study of Turkestan, and the continuation of practical and scientific work in Siberia.

A vast amount of geographical material was accumulated in Russia, only a part of which underwent scientific analysis. Greatest progress was made in the study of the country's orography and hypsometry.

The remarkable journeys of Przhevalsky and Potanin to Central Asia, Chikhachev to Asia Minor and Landsdorf to South America (1821-29) were of particular importance in the geographical explorations of this period.

ABOLITION OF THE SERF SYSTEM IN RUSSIA; FURTHER DEVELOPMENT OF RUSSIAN GEOGRAPHICAL THOUGHT

In 1861 the serf system in Russia was abolished. This produced something of an intellectual uplift in the people which was reflected, amongst other things, in the development of Russian geographical thought.

Various public organisations began to play an increasing role in carrying out geographical work in the latter half of the 19th century. On the initiative of many of the zemstvos (elective district councils) systematic assessment of land was begun in European Russia. The Free Economic Society organised extensive statistical surveys of the population and economy of various regions of the country. The Russian Geographical Society was instrumental in developing these activities and specifically organised a number of major geographical expeditions such as those to Tien Shan and Central Asia.

The uplift in Russian geographical thought at that time affected the most diverse branches of geographical science.

It was precisely in this period that the hypothesis of the great continental glaciation was put forward (N. A. Golovkinsky, P. A. Kropotkin, I. D. Chersky, A. P. Pavlov, et al.), and the theories of the development of river valleys (V. V. Dokuchaev, S. N. Nikitin, et al.), and the formation of lakes (D. N. Anuchin, et al.) and deserts (I. V. Mushketov, V. A. Obruchev, et al.) were elaborated. Important monographs were published on the climate of Russia and the world at large (A. I. Voyeikov, P. I. Brounov, et al.).

The publications of V. V. Dokuchaev on the theory of soil formation and his views on the general tasks facing geography were of particular significance. He wrote: "Recently one of the most interesting disciplines in the field of modern natural science has taken shape and increasingly gained independent existence. I refer to the study of those multiform and diverse correlations and interrelations, and equally to the laws governing their changes over the centuries, which exist between so-called animate and inanimate nature, between a) surface rocks, b) the plasticity of the earth, c) soils, d) surface and ground waters, e) the country's climate, f) plant and g) animal organisms (including, even principally, lower organisms) and h) man, the majestic pinnacle of creation." Dokuchaev believed that this discipline should stand at the very centre of contemporary natural science.

The emergence of soil science, which was concerned with the geography of soils and their formation (V. V. Dokuchaev, K. D. Glinka, S. S. Neustruev, et al.), had a resounding influence on the subsequent development of geographic thought in Russia. Russian ecological biogeography (G. I. Tanifilyev, A. N. Krasnov, G. F. Morozov, N. A. Severtsev, et al.) and landscape science (D. N. Anuchin, L. S. Berg, et al.) evolved as a direct result of Dokuchaev's work. The Soviet scientist V. I. Vernadsky, the founder of the teaching on the biosphere, considered himself a pupil of Dokuchaev.

Dokuchaev's ideas also had a certain influence on the work of the great Russian geographer P. I. Semyonov-Tien-Shansky. At the turn of the 19th century the latter directed work on a fundamental geographical description of the country, published under the general heading *Russia* (1899-1913). Together with A. A. Fortunatov and other scientists he played an important part in carrying out extensive sta-

tistical studies of the country's economy, which laid the foundation of its economic geography developed by Soviet scholars.

Whilst the works of the leading Russian geographers were quite original and of a high theoretical standard, there were still considerable gaps in the overall study of Russian geography before the revolution. This was particularly strongly felt in the years of the First World War, when the country suffered from lack of knowledge of its own natural resources. For this reason the special Commission for the Study of the Natural Productive Forces of Russia (KEPS) was established in 1915 in the Russian Academy of Sciences on the initiative of progressive-minded scientists.

THE EMERGENCE OF SOVIET GEOGRAPHY

After the October Socialist Revolution the young Soviet state set about building a socialist society. Lenin, the founder of the Soviet state, attached great importance to the fullest possible use of the latest developments in science and technology in the planned developing of the economy and exploiting natural resources. A number of organisational and administrative measures were taken by the Soviet Government to improve the work of scientific bodies and, most important, involve the Russian Academy of Sciences in reshaping the economy.

In March 1918 the first People's Commissar for Education, A. V. Lunacharsky, sent a letter to the President of the Academy A. P. Karpinsky suggesting that it take part in resolving the most important economic problems facing the country. In his "Draft Plan of Scientific and Technical Work" (1918) Lenin pointed out that the main efforts of Soviet scientists should be directed towards investigation of the country's natural resources and development of methods for using them throughout the economy.

In 1918 the Department for the Economic and Geographical Study of Russia was established under the auspices of KEPS. This later became the Geographical Institute of the USSR Academy of Sciences, one of the country's leading geographical research institutions. This period saw the creation of many other scientific bodies and institutions which

were to play an important part in the subsequent study of geography in the USSR.

The Russian Academy of Sciences (the USSR Academy of Sciences from 1925 onwards) organised multi-purpose explorations of Siberia and the Far East, Kazakhstan, Turkmenia, Uzbekistan, Kirghizia, Karelia and the Transcaucasian republics. Many local scientific institutions were founded as a result of the Academy's expeditions. These include the branches of the USSR Academy of Sciences which have served as a basis for the establishment of the Academies of Sciences in Union republics and their geographical institutions (institutes and departments).

This period has also seen the foundation of a network of higher educational establishments specialising in the study of geography. Besides turning out young Soviet specialists these institutions carried out extensive research on the country's natural conditions and resources, on the comprehensive use of these resources and on the prospects for the economic development of various regions of the USSR.

The tremendous practical contribution which Soviet geographers have made to the industrialisation of the country, the socialist reorganisation of agriculture, and the expansion and modernisation of all means of communication has played a large part in the successful development of Soviet geographical science.

The rapid and profound specialisation in geographical research and the differentiation of geography were dictated by the needs of practice, which required increasingly accurate and detailed scientific data. Soviet geography has gradually transformed into a complex of sciences. The most advanced of these are: geomorphology, climatology, hydrology, glaciology, oceanology, geographical soil science, physical and biological geography, economic geography (subdivided into industrial geography, agrogeography, the geography of transport and the geography of population and human settlement) and thematic cartography.

During the Second World War the work of all Soviet scientific institutions, higher educational establishments and faculties, including those specialising in geographical science, was directed towards mobilising the country's resources. These efforts after the victory were turned to restoring the economy and developing it on the basis of the latest scientific and technological advances. Major new scientific cen-

tres were set up in Siberia and the Soviet Far East from which new geographical institutions later emerged. Extensive research activity in the Arctic, the World Ocean and later in the Antarctic yielded major scientific discoveries which called for a good deal of courage on the part of the explorers.

On the basis of extensive multi-purpose research on natural resources and the work done on the development and distribution of the country's productive forces a general theory of Soviet geographical science was formulated. Such eminent Soviet geographers as O. Y. Shmidt, L. S. Berg, A. A. Grigoryev, L. I. Prasolov, B. B. Polynov, Y. N. Pavlovsky, V. N. Sukachev, N. N. Baransky and N. N. Kolosovsky have become known throughout the world as the founders of new branches of science—Soviet landscape science, geophysical earth science, dynamic and structural geomorphology, physical climatology and glaciology, balance hydrology, biogeocenology, regional economic geography and other more specialised fields.

It can be said that Soviet geographical science has now taken its place in the forefront of world science through its research on the nature, economy and population of the vast and diverse territory that comprises the Soviet Union.

THE SCIENTIFIC AND TECHNOLOGICAL REVOLUTION, ENVIRONMENT AND THE CURRENT TASKS BEFORE SOVIET GEOGRAPHICAL SCIENCE

Today world geographical science as a whole and Soviet geography in particular is faced with new, extremely responsible tasks. They must resolve the complex problems associated with maintaining the quality of the environment in the face of growing industrialisation and urbanisation, and ensuring that mankind has sufficient natural resources and favourable conditions for life.

The environment is the basis of mankind's existence. It is the source of energy and matter essential for the development of society at all stages of its evolution. But as a result of the scientific and technological revolution and the rapid rate of urban and industrial development society's influence on the environment has reached unprecedented proportions and shows a tendency to increase at an even greater

speed. Regional shortages of various natural resources are now in evidence and we can see signs of irreversible global disturbances in nature, some of which are dangerous and harmful to man. There is a real threat of man disturbing the natural matter and energy balances and the ecological conditions of life. This represents a threat to the further existence of human society.

In the current environmental situation there is a clear contradiction in the influence of the scientific and technological revolution. On the one hand, the growing might of technology and the increase in production of materials and energy are intensifying man's multiform pressure on the natural environment. On the other, the great achievements of science and technology enable man to use new substances, harness the forces of nature and employ new technical developments, satisfy more fully his numerous demands and arm himself with powerful weapons for influencing the environment in such a way as to protect and improve it. This latter aim, which is often referred to as the purposeful transformation of the environment, is coming more and more into the foreground. It presupposes the creation of conditions of habitation most suitable for man. Clearly the whole diversity of the practical work directed towards this end should be based on many-sided theoretical developments in science. In other words they should be developed by an extensive system of sciences.

At the same time there must obviously be close contact between all branches of science in tackling the problems we have just mentioned. It is therefore exceptionally important to work out a single strategy in the organisation and realisation of comprehensive scientific research and subsequent synthesis of the results obtained. At the current stage of development of scientific knowledge geography must play a leading role in organising integrated elaborations of this kind. This follows from the fact that geographical sciences have long since adopted a systematic approach to the study of phenomena in nature and society, analysed their individual elements and subsequently synthesised them, and covered the internal and external interconnections of the systems investigated.

At present the most important areas of research may be defined as follows:

— Determination of society's requirements in natural

resources; discovery of new sources of these natural resources and their economic evaluation;

— Comprehensive study of the influence which modern society's industrial activity exerts on the environment and the consequences of this influence;

— Development of theoretical and methodological principles for forecasting scientifically the effects produced on the environment by the scientific and technological revolution;

— Elaboration of a general scientific theory of purposeful transformation of the environment to optimise the conditions of life and man's activity and development of effective regional models for the most rational territorial organisation of society's productive forces.

There is every reason to believe that Soviet geography will successfully resolve these important new problems. This conviction is based on the major part played by Soviet science in the creation of the material and technical basis of communist society and on the fundamental and promising achievements of Soviet geography with which this book is concerned.

Moscow
December 1974

Academician I. P. GERASIMOV

Part I

RUSSIAN GEOGRAPHY BEFORE THE REVOLUTION

RUSSIAN GEOGRAPHY IN THE 16TH AND 17TH CENTURIES

Growing interest in geography in the 16th and 17th centuries was a direct consequence of the amalgamation of the Russian lands into the centralised Muscovite State.

The authority of the Muscovite State both in Western Europe and in the East grew as it became more powerful. The Papal throne in Rome, German emperors and the Venetian Republic exchanged ambassadors with Muscovy. Diplomatic relations were established and promoted with Moldavia, Turkey, Persia, as well as with neighbouring Poland, Lithuania and Sweden. The Muscovite State's trade relations grew at the same time.

After Chancellor's British expedition reached the mouth of the Northern Dvina by sea in 1553, Moscow began to trade extensively with other nations of the world. Every year several dozen merchant vessels came mainly from Britain and Holland first to Kholmogory, and from 1584 onwards to Arkhangelsk, situated at the point where the Northern Dvina falls into the White Sea. The government of Russia strived to broaden these ties in its negotiations with Britain, Sweden and Denmark. In addition to the ports of the Northern Dvina Moscow was in possession (until 1583) of the port of Ivangorod on the Baltic Sea near Narva, which it used to trade with the Scandinavian countries. Overland trade with Poland was conducted via Smolensk. Meanwhile trade with the East was also very important. Most of the routes passed through Astrakhan, which was a major trade centre. One trade route from Astrakhan led along the Western coast of the Caspian Sea to Georgia, Armenia and Persia; the other to Bukhara and Khorezm in Central Asia.

After Kazan and Astrakhan had become part of the Russian State in the middle of the 15th century, the latter city began to play an even more important part in Western Europe's trade with the central Asian states and Persia. British and Dutch trading companies tried to obtain from Moscow exclusive rights to trade with the East. At this time the Kama and Pechora river basins in the Ural region were increasingly involved in the Muscovite State's sphere of interests. Russian merchants moving north through Vologda, Veliky Ustyug and Sol Vychegodskaya along the Vychegda and the tributaries of the upper Pechora penetrated to the eastern slopes of the Urals and emerged at the upper reaches of the river Ob's tributaries and along these to the Ob itself, on the threshold of the West Siberian Plain. Systematic settlement of the upper reaches of the Kama, Pechora, Sylva and Chusovaya rivers quickly opened up what were once almost uninhabited parts of Siberia.

Shortly after the lands of the lower Ob and Irtysh basins had been settled, groups of explorers made up of Cossacks moved further to the north and east building winter cabins and forts for protection and rest as they went. They used information obtained from the Tunguses, Buryats, Yakuts, Yukagirs and other local inhabitants. Travelling in summer by boats along the rivers and in winter on skis Russian explorers reached the lower reaches of the Yenisei by the year 1607; the rapid advance to the east by the *zemleprokhodtsy* in the 1720s was sparked off by the development of the Russian economy, whose influence also affected Siberia, and the mass migration to Siberia of peasants trying to escape serfdom in the European part of the country. After the traders the Moscow government sent out military personnel who built settlements on the main routes taken by the pioneers, developed roads and took control of the newly-acquired lands.

Among the strongholds established in Siberia were the towns of Tyumen (1586), Tobolsk (1587), Tomsk (1604), and the forts (*ostrogs*)—Yeniseisky (1619), Ilimsky (1630), Bratsky and Kirensky (1631), and Lensky (1633) which was moved to the west bank of the Lena ten years later and renamed Yakutsky Fort or Yakutsk for short. The basin of the Lena River became tremendously important both from the economic and political points of view. It formed the central point in the development of Siberia's natural resources after

the discovery of salt, and iron and copper ores. At the same time land cultivation was started in various regions of Yakutia.

Many expeditions to the east by the shortest route to the Pacific Ocean and to the lower reaches of the Lena in the north were organised from Yakutsk by the local voyevodas. A detachment of Cossacks under Ivan Moskvitin were the first Russians to reach the Sea of Okhotsk (1639) at the mouth of the river Ulya. Here the first Russian settlement was established on the Pacific Ocean coast. From this winter stronghold Moskvitin undertook several voyages along the shores of the Sea of Okhotsk: as far as the Taui Gulf in the north and to the Uda River, the Shantar Islands and the mouth of the Amur River in the south.

Yakutsk was also the point of departure for the first voyages down the Lena, and from here through the Arctic Ocean towards the rivers Olenek and Khatanga in the west, and the rivers Omolon, Yana, Indigirka and Kolyma in the east. Sea voyages were made from the mouths of the Lena, Kolyma and Indigirka rivers. Thus Yakutsk became connected by sea with the new Russian settlements in the north-east of Siberia.

All this allowed the Russian voyevodas in Yakutia to keep abreast of events, learn about new discoveries and facilitate the work not just of the local authorities, but of the traders who brought in large amounts of furs for the State. The Russian pioneers pushing on even further to the east discovered routes to the rivers Anyui and Anadyr in the extreme north-east of Asia. In the mid-1640s news was received of the discovery opposite the mouth of the Anadyr of the "Big Land"—Alaska.

A series of discoveries in the eastern part of the Arctic Ocean area concluded with the remarkable voyage of S. I. Dezhnev, who left the Kolyma River with seven ships in June 1648 and passed through the strait separating Asia and America somewhere in September after rounding the cape which now bears his name. Dezhnev had quite a clear idea about the significance of his discovery. He reported that the ocean was divided by this cape into the "Freezing Sea" to the north, and the "Eastern Sea", that is the Pacific Ocean, to the south. Dezhnev's voyage marked the final stage of the Russian explorers' efforts to reach the north-east frontiers of the Asian continent.

Thus in a little over half a century ordinary Russian people—Cossacks, traders, fur-trappers and seal-hunters had traversed the entire continent of Asia from west to east.

As the Muscovite State's political and commercial links with foreign countries expanded, the need grew among Russian people for greater geographical information not just on these particular countries and the routes leading to them, but on the world as a whole. At that time, however, a major part of this information came from translations of foreign authors and Russian treatment of their contents. Among the works translated from Latin, Dutch, Polish and other languages by the middle of the 17th century mostly by Russian clerks of the Foreign Affairs Department were those of the Flemish geographers and cartographers Gerhardus Mercator and Abraham Ortell, and *De City Orbis* by the first-century Roman geographer Pomponius Mela, which was first published in Europe in 1471 in Latin. These translations, which were made in the first half of the 17th century, were preceded by a translation of the widely-known work of the Polish scholar Martin Bielski—*Kronika, to jest historia Swiata* ("Chronicle of the Whole World"). Apart from historical information on events beyond the frontiers of Russia this book, which was published in Krakow in 1554 and again in 1564, contained a great deal of geographical information on many countries as well as information on the Universe. Bielski's work was extremely popular in Moscow in the late 16th and early 17th centuries.

According to P. P. Pekarsky the book *Kosmografiya, sirech vsemirnoye opisaniye zemel vo yedino prebyvaniye i znamenovaniye v krugakh nebesnykh* (Cosmography or A Description of the Lands and Phenomena Occurring in Celestial Circles) was translated into Russian around 1603 and its numerous hand-written copies were very popular with Russian readers. Academician A. I. Sobolevsky suggests that this work is based on Ortell's *Theatrum Orbis Terrarum*, which appeared in 1571. Apart from a description of the earth and the four continents known at that time (Europe, Asia, Africa and America) the book contained a great deal of information on the way of life and occupations of the peoples of different countries, on the articles they produced and their home and foreign trade. There were many such geographical works in Moscow at that time. A mere comparison of the dates of foreign publications with the dates of their trans-

lation into Russian shows that in the 16th and in the first half of the 17th centuries relatively new works had no priority in translation over old ones, whilst in the latter half of the 17th century it was principally the latest European geographical works that were the object of translation. Such was the case for the translation of Dutch cartographer and publisher Willem Blaeu's *Theatrum orbis terraris sive Atlas novus*, the first volume of which appeared in 1635. Apart from quite detailed maps of European countries this atlas contained maps of all the lands discovered in America and those en route to India, Indonesia and China. It is interesting to note that the translation of the introduction to Blaeu's atlas contains the first account in Russian of the systems of Ptolemy and Copernicus. No clear preference is given to either of the systems, although both the author and the Russian translators were inclined to consider Copernicus's teaching as the more valid and worthy of recognition and support. The manuscript of the translation of this atlas, which is kept in the Central Museum of History in Moscow, was drawn up in the 1650s and completed not later than 1661. The translation was used as an explanatory text to the maps in the atlas.

There must have been a great need for explanatory texts in Russian as an aid to using the maps of those days, since we know of the translations of similar publications (e.g., De Groot's Dutch sea atlas published in 1688) besides the text to Blaeu's atlas.

Among the seventeenth-century translations displaying clear signs of independent Russian treatment of foreign sources are works having some bearing on mathematical geography. The fact that a large number of these works existed indicates where the interests of the Russian readers of the day were concentrated. They contained information on the position of the equator, on the ecliptic as a great circle of the celestial sphere along which the sun moves during the year, on the times of sunrise and sunset, on geographical latitude and longitude and the division of the equator into 360 degrees, and finally on the latitudinal position of the largest cities and islands—"what stands where" (quoted from Rainov).

Russian literature of the 17th century thus contained the essential ideas and conceptions of geography, but was lacking original elaborations in the field of general theoretical

aspects of geographical science, being restricted to translations and compilations. At the same time the selection of the most interesting West European geographical works for translation clearly shows that Russians were well acquainted with this literature.

It is important to note that, as a rule, the Russian translators of this literature introduced into their translations where necessary more correct information, especially when this referred to Muscovy or the well-known countries of Central Asia or the Caucasus. Corrections of this kind appear, for example, in the translation *Knigi, glagolemoi kosmografiya. Opisaniye vsego sveta i gosudartstv velikikh* (A Book Named Cosmography. A Description of the Whole World and the Great States), known in many manuscript copies in Russian literature as *Kosmografiya 1670.* (Cosmography in the Year 1670) or *Kosmografiya v 76 glav* (Cosmography in 76 Chapters). They were mainly based on the extensive geographical data of Gerhardus Mercator and Martin Bielski, but this data was used so freely and with such great rearrangements and changes that it is sometimes difficult to discover the sources used by the translators, or to be more precise, compiler. It was this apparently that prompted Academician A. I. Sobolevsky to suggest that *Kosmografiya v 76 glav* was a translation of an unknown compilation of German origin. It would seem however that this work is an independent Russian review of various foreign sources in which the compiler substituted or partially changed the text of the foreign authors to comply with Russian data. Mercator's *Cosmography* was extremely popular with Russian readers of the day. This is substantiated by the fact that more copies of this translation were produced than of any other foreign geographical work translated into Russian.

The first information on Siberia and the Ural region is to be found in the fourteenth-century Russian chronicle *Povest vremennykh let* (Chronicle of Bygone Years). The end of the 16th century saw the appearance of the first summary geographical reviews, which covered mainly the long-inhabited territories of the Muscovite State on the Russian Plain, and the famous *Bolshoi chertezh* (Great Chart) of the Muscovite State, which made a tremendous contribution to the science and practice of those days. Neither the original Chart, nor the explanatory text to it, the *Book of the Great Chart,*

the remaining manuscript copies of which were made in the latter half of the 17th century, have survived to the present day.

From the list of geographical names contained in the manuscript copies of the *Book of the Great Chart* one can conclude that the *Chart* covered a vast territory stretching from the Barents Sea and its islands of Kolguyev anad Vaigach to the Black Sea, and from the Gulf of Finland and the delta of the Neva in the west to the valley of the Ob and even (although in much less detail) to the river Yenisei in the east. The compilers of the *Chart* and the *Book* knew of places on the southern shores of the Caspian Sea and in Transcaucasia. The *Book* mentions the "Urgenj Kingdom"—Khiva and Bukhara, the Asia Minor coasts of Turkey and the regions of northern Iran. All this suggests that the compilers of the *Great Chart* and the *Book of the Great Chart* had a great deal of geographical information at their disposal and possessed undoubted geographical vision.

The *Book of the Great Chart* contains mainly political, economic, military and geographical data. Most of the geographical material is arranged in such a way as to cover areas from Moscow outwards, the most distant posts of the State being dealt with at the end of the book.

In addition to the *Book of the Great Chart* and various kinds of *dorozhniks* (route guides) geographical information in the 16th and 17th centuries was conveyed in the following documents: *pistsovye knigi* (cadastres), which were summary registers of lands and their usage; *smotrennye knigi* (traveller's guides) containing data on the location of human settlements, (particularly in border areas), on the distances and roads betweeen them; *opisnye knigi* (descriptive books) containing descriptions of towns, villages and cloisters. By the middle of the 17th century the *perepisnye knigi* (census books) appeared which gave summary information on the size of Russia's population.

These documents, together with the large number of regional charts, made up the stock of literature from which many foreigners visiting Moscow drew material on the geography and cartography of Russia.

Many foreign books which contained unchanged as well as rewritten information on Russia made direct or indirect reference to its Russian origin. There is however every reason to believe that any book or cartographical work published

in the 16th and 17th centuries in Western Europe which describes or depicts the territory of Russia even if it does not mention the Russian origin of information was based on Russian material, since foreigners were denied access to the interior of the country and, as a rule, had little idea of the territory of Russia. It should be added that for a number of reasons, chiefly because of a poor knowledge of Russian, the geographical descriptions and maps of the Muscovite State published in Europe contain many flagrant errors, inaccuracies and distortions.

It is thus quite clear that the maps of the Muscovite State published abroad by S. Herberstein (1546), H. Gerritsz (1613), I. Massa (including the most interesting of his maps of 1633) and N. Witsen (maps published in the 1680s and 90s) did not represent their independent creative work. They were as a rule copied from Russian charts and changed only slightly to conform with the style of cartographic representation used in Western Europe. It is precisely for these reasons that the publications in foreign countries of maps of the Russian State contain such glaring errors, which could not have occurred if their authors had had first-hand knowledge of Russian territory.

The frank words of the famous Dutch geographer and cartographer Isaac Massa pronounced on his return to Holland from Moscow where he lived from 1601 to 1609 may give at least some idea of the Russian sources which formed the basis for many foreign maps and the methods which foreigners used to obtain them. In particular he wrote that he was obliged for the information obtained "with the greatest difficulty" to his "friendship with several Moscow courtiers, who as a favour to me, imparted this information after they had denied it for such a long time".

By analysing and comparing Russian charts published from the late 15th to the 17th centuries and the maps and atlases published in Western Europe in the same period Academician B. A. Rybakov has proved convincingly that the maps of Muscovy drawn up by European cartographers were based on early Russian sources. The following three examples will illustrate this: Englishman Anthony Jenkinson's map of 1562 was drawn up some 65 years after the publication of the Russian source from which it came—a Russian chart of 1497; Dutchman Hessel Gerritsz's map of 1613 was compiled 90 years after the Russian original; Guillaume De-

lisle of France based his map of 1706 on a Russian chart drawn up in 1526. The view subscribed to in foreign geographical literature that before the early 18th century Russia was studied and described only by foreigners is therefore no more than a delusion. Many of the foreign authors who wrote about Russia including the newly-discovered lands in Siberia were no more than compilers and commentators using as their basic material original Russian sources. Knowing the conditions in which such material was kept and the difficulty of access to it we can say with certainty that in those days foreigners could only use a very small part of the existing Russian documents and so the standard of their reports, made even worse by ignorance of the language, was considerably lower than "that practical, albeit unformed scientific geographical knowledge of Russia which the Russians themselves possessed", as D. M. Lebedev has written. Nevertheless for all their shortcomings and errors sixteenth- and seventeenth-century foreign publications on Russia preserve the kind of material that permits us to judge of both the numerous documents and charts which have been irretrievably lost, and the many lists of the documents on which these charts were based.

We can obtain some idea of the number and contents of the charts that have been lost from the research of A. A. Gozdavo-Golombievsky and his published list of 248 charts preserved in the War Department. Apart from the map archives of the War Department there were hundreds of other charts kept in various government departments at that time. But even in the storerooms of the Siberian Department, where a great many maps were once kept, the historian and archivist N. N. Ogloblin found only three charts in the 1890s. Moreover archives containing a wide range of geographical documents and charts were to be found not only in administrative centres, but in distant, relatively insignificant forts such as Anadyr or Bolsheretsk in Siberia and Nizhnekamchatsk in Kamchatka. Thus we can see how much has been lost over the years.

The question arises as to how these documents of the 16th and 17th centuries were accumulated and from where they originated. Despite the vast amount of material lost, we still continue to draw from them valuable facts about the volume and nature of geographical knowledge acquired by Russian people in those days.

In accordance with the established practice of organising para-military detachments including various kinds of volunteers—traders, fur-hunters, trappers—to go in search of unknown lands the voyevodas gave these people special written orders, or if there were no literate people in the party,—verbal instructions. But in all cases particular demands were made of the pioneers as regards the gathering of information needed by the authorities on routes to the new lands, on the people inhabiting them, their way of life and occupations, and on natural resources—iron, lead and tin ores needed to make weapons, furs, precious metals and stones, salt deposits, etc. They were also asked to note which cereals were sown and what sort of yields were obtained, which animals were bred and how many of them populated the places visited. At the same time the orders required that the members of the detachments compile special reports containing amongst other materials geographical information to which maps of the route taken had to be affixed.

Rasprosnye rechi, (interrogation or examination records), which sometimes contained valuable geographical information on regions of Siberia still unknown to the Russians, were made by voyevodas' personnel and departmental clerks from the words of Buryats, Yakuts, Tunguses and other local inhabitants. We know of only a part of this material which gives a reflection of the work of the Russian pioneers in studying new territories. Even now publications of previously unknown documents and maps come to light from time to time.

All this valuable geographical information which came to local administration centres in Siberia, and from there to Tobolsk and Moscow, was then further processed and collated. The summary charts were the direct results of this work. Apart from the *Great Chart* they included the chart of voyevoda of Tobolsk, P. Godunov, which was drawn up in 1667 and covered the whole territory of Siberia. This chart is now preserved in several copies.

The numerous charts of the well-known Siberian geographer and cartographer S. U. Remezov represent a most interesting monument to Russian cartography. Remezov compiled three atlases: *Khorograficheskaya chertezhnaya kniga* (Chorographical Book of Charts), *Chertezhnaya kniga Sibiri* (Book of Charts of Siberia) and *Sluzhebnaya chertezhnaya*

kniga (Official Book of Charts). Although most of Remezov's maps were drawn up in the last quarter of the 17th century and the first decade of the 18th century, his works reflect a definite historical stage in the development of Russian cartography before the reign of Peter the Great which laid the foundation for the subsequent transition from charts to maps having a mathematical basis. Remezov's charts reflect an abundance of detailed and, in the majority of cases, authentic geographical information. They have deservedly become famous throughout the world as comprising a graphical representation of geographical discoveries and the annexation of Siberia.

REFORMS OF PETER THE GREAT. ORGANISATION OF THE ACADEMY OF SCIENCES AND ITS TASKS IN THE FIELD OF GEOGRAPHY

The reign of Peter the Great in the late 1690s and the first quarter of the 18th century holds a special place in the history of Russian science. After a careful study of historical sources Academician O. V. Struve concluded in the latter half of the last century that during the reign of Peter I geography developed more rapidly than any other science, for it was geography which played the leading role in helping Peter I carry out his major political and economic reforms. Academician K. M. Ber took a similar view in an extensive work on Peter the Great's part in the development of Russian geography.

Reliable knowledge of the geography of Russia and the rest of the world was essential for successfully resolving many of the political and economic problems of Peter the Great's home and foreign policy programme. It was impossible to exploit the various natural resources of Russia's vast territory without first obtaining a clear idea of their geographical distribution. The navy which Peter I created needed accurate geographical maps. These were also constantly required for solving various other political tasks. This explains the advanced position achieved by Russian cartography at that time. At this time Russian cartography acquired the services of geodesists who could carry out instrumental surveys, determine geographical coordinates and draw up relatively accurate maps with grade grids. This was a real revolution in the field of cartography. And the initiator of these de-

velopments was Peter I himself, who from an early age was extremely interested in various methods of compiling maps.

Peter I wanted Russia to have its own native geodesists. For this reason the first Navigation School was set up in Moscow in 1701 to train navigators versed in the fundamentals of geodesy. The Naval Academy founded in 1715 began turning out even more highly qualified geodesists. All this bore fruit and in the second and particularly the third decades of the 18th century there was a noticeable increase in the number of regional maps compiled on a mathematical basis in many provinces of Russia.

Peter I realised the great significance to the State of having widespread knowledge of geographical sciences in Russia. For the first time in Russian history geography was taught not only in secular schools but in theological institutions. Special examinations on geographical maps were introduced. Even the Ecclesiastic Regulation obliged students to remember that "history without geographical knowledge is like walking blindfolded along the street".

Naturally all this required that maps of various countries of the world be printed on a large scale. From 1705 onwards this work was carried on under the guidance of V. O. Kipriyanov, a former teacher at the Navigation School, in the Moscow Public Printing House, which, as D. M. Lebedev has rightly noted, was essentially "the first Russian cartographical institution involved in scientific research and production". Here they produced the first Russian maps of America, Africa, Asia, Europe and the two hemispheres. In 1711 the first large-scale map of the Moscow *gubernia* (province) was printed. Kipriyanov also published maps of the "celestial sphere". It is important to note that in 1707 the first edition of the "celestial sphere" gave a "Discourse on the Arrangement of the Whole World According to Copernicus".

As soon as he came to the throne, Peter I ordered the most diverse geographical information to be gathered in the field. During his reign the people who had travelled to distant parts were questioned in much greater detail than before about the lands they had visited. From around 1715 scientists were sent out for the first time to explore different parts of the country. The expedition of A. Bekovich-Cherkassky played an important part in obtaining knowledge of

the geography of the Caspian Sea and Transcaspia. Thanks to the work of this expedition a new map of the Caspian Sea appeared in Russia in 1715. Peter I was extremely proud of this map and personally exhibited it in Paris in 1716 and on June 19, 1717 at a session of the Paris Academy of Sciences.

Soon after this Peter I commissioned K. P. Verden and F. I. Soimonov, who were both navigators and geodesists, to carry out a new survey of the Caspian Sea. They drew up even more accurate map which Peter I decided to present to the Paris Academy of Sciences as he had done with the first one.

At this time Peter I became firmly convinced of the need to institute an academy of sciences in Russia. He believed that the creation of such an institution would help develop knowledge more quickly "for the greater good of the State". On January 28 (February 8) 1724 Peter I signed a Senate decree on the institution in St. Petersburg of the Academy of Sciences. He was convinced that it would become the main scientific centre for resolving the most important geographical problems, discussing new geographical undertakings and discoveries, creating new, improved maps and globes, publishing new books on geography, and propagating geographical knowledge through the printed and spoken word. Peter I was certain that the new Academy would add to Russia's fame.

To achieve this purpose the Academy of Sciences was divided into three "classes" or departments. The first department embraced mathematics and associated sciences. It also included geography, for Peter I considered that further advances in cartography were entirely dependent on the progress of mathematics and astronomy. It was the job of the first department to carry out the theoretical research which would give geographical maps the maximum accuracy. And it is no coincidence that the declaration of the first assembly of the Academy of Sciences, which took place in 1725 after the death of Peter the Great, mentioned that its members intended to concern themselves with solving "the most difficult question of establishing the longitude of places on the land and on the sea". Extensive work was done at the Academy in this connection on copying old maps and drawing up new ones. As a result of this the Academy developed a good working relationship with the cartographer I. K. Ki-

rilov, and later with the eminent Russian scientist V. N. Tatischev.

The Academy of Sciences also played a considerable part in propagating geographical knowledge among the Russian people. Popular science articles on geography written by the staff of the Academy often appeared on the pages of *Notes* which supplemented the *St. Petersburg Gazette* and in the *Calendars*, which were specially issued by the Academy and enjoyed great popularity in Russia at that time. These publications often contained information from foreign books on geography since the Academy was now the main translation centre. In the late 1720s and early 1730s the Academy published a series of articles on Siberia and the Far East based on the book *North and East Tartary* by the Dutch geographer Witsen.

Lectures and papers on geographical topics were often read at the Academy whose staff sometimes gave lessons in geography. Academician Miller (Müller), specialising in the history of Siberia and the geographical discoveries made there, began his work with the Academy in this very way in 1726. Later such eminent Academicians as J. N. Delisle and C. Winsheim were giving lectures on geography. The Academy staff also had a hand in compiling a number of geography text-books.

The staff of the Academy had at their disposal a magnificent library, the priceless contents of the Kunstkamera and manuscript materials, but at first they did not have sufficient funds to organise their own scientific expeditions. The position only changed in the early 1730s when the government decided to include several Academy scientists in the Second Kamchatka Expedition to Siberia under the leadership of Vitus Bering.

After Peter I learned that the navigator Nikifor Treska had made the first direct voyage from Okhotsk to the west coast of Kamchatka in 1716, he ordered that the experienced geodesists I. M. Yevreinov and F. F. Luzhin be sent to Kamchatka on the same vessel to describe the local places and discover whether America was joined to Asia or not. In 1697 Peter I had discussed this question with Witsen, who in accordance with the Dutch hypothesis of 1643 believed that the North America was closest to Asia in the area to the south of the Kuril Islands and that the "Company Land"—Urup Island—was a part of the north-west coast

of North America. For this reason Yevreinov and Luzhin, following Peter the Great's personal instructions, set off in search of the coast of America along the shores of the Kuril Islands. Needless to say, they did not find America, but they did compile a grade grid map of Kamchatka and the northern Kuril Islands.

In order to discover where Asia was closest to America and find its north-west coast Peter I sent a special expedition (1724) led by Vitus Bering, who was instructed to follow a course different from that of Yevreinov and Luzhin. He was to set out from the coast of Kamchatka towards California, bypassing the legendary Land of Juan da Gama which at that time was thought to be situated in the Pacific Ocean between Asia and America. On his way through Siberia Bering met up with the naturalist D. Messershmidt in the town of Yeniseisk. The scientist showed Bering Witsen's map (1690) of Tartary (Northern Asia). In place of Chukotsk the map depicted the unfinished coastline of a peninsula stretching towards America whose extremity, as was explained on the map, had not yet been drawn, as the area had not been explored. The map was dedicated to Peter I who had shown an interest in it at one time. This gave Bering the idea of setting out towards the eastern extremity of the Chukotka Peninsula and there seeking the "junction" between Asia and America.

At the time Bering did not know that in the middle of the 17th century the Cossack Dezhnev had for the first time reliably established that the Chukotka Peninsula is washed on three sides by the sea and, as a result, not linked with any other continent.

Between 1730 and 1732 the Academy of Sciences not only directly participated in discussing the results of the First Kamchatka Expedition, but drew up a compilatory summary map of the northern Pacific Ocean, on which was marked (on the instructions of Peter I) Bering's new route from the south of Kamchatka to the coast of North America south of the mythical Land of Juan da Gama (alias "Northern Land", or "Land which stretches to the North").

It should be noted that in 1732, before the Second Kamchatka Expedition was sent to the Far East, two Russian navigators—I. Fedorov and M. Gvozdev—became the first Russians to reach the coast of America from Chukotka. They visited the extreme west of Alaska which they took

to be a separate "Big Land" (*Bolshaya zemlya*). Although Alexei Chirikov suggested in the 1730s that this land might be a part of America, this was only established conclusively after the Second Kamchatka Expedition. The Academy of Sciences once again played an important part in solving this problem. Its staff brought the discovery of I. Fedorov and M. Gvozdev to the attention of world geography.

Thus from the time of its inception in 1724 the St. Petersburg Academy of Sciences successfully tackled those geographical problems which Peter the Great's programme of reforms had put before it. The central problem facing geographers, astronomers and mathematicians of the Academy was that of improving the methods of compiling Russian geographical maps. By increasing the accuracy with which coordinates were determined, seeking the most suitable projection for maps of Russia's territory and improving the quality of map drawing the Academy contributed to the progress of Russian cartography.

At the same time the Academy became the main centre for the propagation of geographical knowledge both inside Russia and abroad. It was at this time that scientific processing of geographical information gathered in the field began. Thus in the early years of its existence a sound basis was laid for the further progress of Russian geographical science.

THE GREAT NORTHERN EXPEDITION. S. P. KRASHENINNIKOV—THE FIRST GEOGRAPHER-ACADEMICIAN

The Kamchatka Expedition, which began in January 1725, was the first Russian expedition organised after the foundation of the Academy of Sciences. The expedition's task was "to find where it (Asia) joined America", as stated in the instruction to its leader, Vitus Bering, signed personally by Peter I on January 6, 1725. Peter I probably wanted to have precise information about the extent of the Russian State in the east and to know the location of America and the cities of "European powers" situated on its territory, and that of other neighbouring states, particularly Japan. Unfortunately, Bering's first Kamchatka Expedition was unable to give a well-founded and complete answer to the questions it set out to resolve. The Senate and the Admi-

ralty Board, at least in the period following Bering's return to St. Petersburg in 1730, adopted a negative attitude to the report and maps presented by Bering first in the form of a preliminary report sent from Siberia on February 10, 1730, and subsequently in a fuller final report compiled in St. Petersburg in April of the same year.

On the summary map of Bering's first expedition it was only possible to see Kamchatka, the Chukotka Peninsula with the Pacific coast between them and the eastern coastline of the Arctic Ocean adjoining Chukotka. Bering's maps were extremely accurate for their time. This was confirmed at the end of the 18th century by Captain James Cook who noted that Bering's observations were so accurate and the position of the coast was marked so correctly that it would have been impossible to better them with the mathematical textbooks at his disposal.

In April 1730, that is just over a month after his return from Kamchatka, Bering informed the Senate of his idea of sending a new expedition which would seek routes to America and the islands of Japan. At the same time Bering first advanced the idea of surveying the Arctic Ocean coast, primarily in the area between the Ob and the Lena, round the completely uncharted Taimyr Peninsula, and to the east of the Lena. To accomplish a special mission in which the Academy of Sciences was involved for the first time, Bering further requested that a special detachment make a comprehensive survey of natural conditions and population both in the charted areas of Siberia and in the lands that were then being discovered.

Bering's Second Kamchatka Expedition, or, as it is often called, the Great Northern Expedition, was a major scientific undertaking, which went on for over ten years. The expedition's achievements were not fully appreciated by Bering's contemporaries and only received due acclaim in later years.

The northern group of the Great Northern Expedition was comprised of four detachments. Their task was to gather the material necessary for compiling a map of the Arctic Ocean coast between the city of Arkhangelsk and the point where the Arctic Ocean joined the Pacific Ocean. This had to be done before they could solve the problem of the north-east passage from Europe round Siberia to Anadyr, Kamchatka and on southwards to the mouth of the Amur, and

to Japan and India. The task of the northern group was made more difficult by the fact that they had to work in previously unknown territories where there were almost no permanent settlements.

Investigations in the western strip from Arkhangelsk to the Ob were first carried out under the leadership of Lieutenant S. V. Muravyev and his assistant, Lieutenant M. S. Pavlov, in two vessels, the *Ekspeditsion* and the *Ob*, which measured just 16,5 metres in length. In two years of sailing (1734 and 1735) the vessels only managed to reach the western coast of the Yamal Peninsula. As the detachment suffered many misfortunes on the voyage, three other lieutenants—S. Malygin, A. Skuratov and I. Sukhotin—were commissioned in 1736 to continue the explorations. They completed their work three years later, when Lieutenant Skuratov brought both ships, which had sailed as far as Beryozov on the Ob, back to Arkhangelsk. As a result of the detachment's work the entire western part of the Kara Sea coast and the lower reaches of the Ob were charted for the first time. The famous explorer of the northern seas Admiral F. P. Litke wrote about the detachment's work in his book of 1828, that "the physical difficulties were so great, and the resources which they were given to overcome them so meagre, that we should be more surprised by what they achieved than by what they did not achieve".

In May 1734 Lieutenant D. L. Ovtsyn's detachment began its explorations along the coastline from the Ob to the Yenisei in the vessel *Tobol*. Three times in the years between 1734 and 1736 Ovtsyn attempted to enter the Kara Sea from the Ob, but each time the ice defeated him. The summer of 1737 proved more favourable for sailing and the *Tobol* together with the detachment's second vessel, the *Ob-Pochtalyon*, not only succeeded in leaving the Gulf of Ob, but carried out a survey of the coast of the Gydan Peninsula. After reaching the Gulf of Yenisei Ovtsyn's vessels were able to sail up the river almost to the mouth of the Turukhan. Thanks to the well-organised work of the auxiliary parties which Ovtsyn sent out over a period of four years in boats, on foot and on reindeers, his detachment studied the coast of the Gulf of Ob, the Kara Sea between the Ob and the Yenisei and the Yenisei River valley itself. All the necessary material was gathered to compile a map of the region explored.

Lieutenant Ovtsyn was, perhaps, the most active and talented organiser of explorations in the North. By making skilful use of the men and materials at his disposal he exceeded the bounds of his commission to explore the Kara Sea coast between the Ob and the Yenisei and in 1738 sent navigators F. A. Minin and D. V. Sterlegov in the *Ob-Pochtalyon* from the Yenisei to the mouth of the Khatanga River around the Taimyr Peninsula. At that time they had no exact knowledge of how far the peninsula stretched to the north.

Despite the fact that the main mission of the sub-detachment—to round the Taimyr Peninsula by sea—was unsuccessful, the explorations which they made in the area to the east of the Yenisei were of great significance. Apart from exploring unknown territory they described sailing conditions in the Gulf of Yenisei and even marked navigation channels on the chart. The latitudes reached by Minin remained the highest in the eastern Kara Sea up to the time of Nordenskjöld's voyage in 1878.

Between 1738 and 1740 Minin and Sterlegov began to explore the northernmost part of the Arctic Ocean coast between the Yenisei and the Lena (and Cape Chelyuskin, the most northerly point on the Asian continent) from the west. But the major role in studying the Taimyr Peninsula both by sea and in the numerous land expeditions fell to the detachments of Lieutenant V. V. Pronchishchev, Navigation Officer S. I. Chelyuskin and Lieutenant K. P. Laptev (1735-40). The topographical surveys and description of the coast of the Taimyr Peninsula made by these detachments constitute, along with the work of Ovtsyn, Minin and Sterlegov, the most significant scientific achievement of the northern group of the Great Northern Expedition.

The most successful of the explorers in the northern group was S. I. Chelyuskin who surveyed the entire Taimyr Peninsula. On his last journey, whilst moving along the eastern coast of the Taimyr Peninsula, he reached a place where the coast, which until then had followed a north-westerly direction, fell away sharply to the south-west and then the south. This was the northernmost point of the Asian continent, which Chelyuskin named the Eastern North Cape.

Among the scientific documents of the Great Northern Expedition we are fortunate to have in our possession the manuscript of K. P. Laptev—a supplement to the general

report on the explorations which his detachment made between the Lena and the Yenisei. Apart from the fact that it contains the first description of the geological structure of the coast and the rivers falling into the sea, this interesting document is extremely valuable for its outline of the precise northern limit of arboreal vegetation along the valleys of the Yenisei, Pyasina, Khatanga, Anabar, Olenek and Lena rivers. Laptev's observations—the first of their kind—are also interesting for the fact that when compared with present-day data on the limit of arboreal vegetation they allow one to judge the drop in temperature which has taken place since then and the associated regression of forests far to the south (by 2, 2.5 or even 3 degrees of latitude). Laptev was among the first persons to attempt to analyse the widespread phenomena in Siberia of tree trunks lying in disorder sometimes a long way from the coast and at a considerable height (up to 20 metres). He suggested that they had been drifted by sea when the water level had been higher. In those days it was traditional to associate such phenomena with the Flood, but Laptev categorically rejected such an explanation and considered that natural elements must have been responsible.

Explorations to the east of the Lena undertaken on the *Irkutsk*, which was commanded first by Lieutenant Pyotr Lasinius and subsequently by D. Y. Laptev, were of great significance. These were the first accurate geographical investigations to be made in this region. Later the well-known investigator F. P. Wrangel, who visited this part of the Arctic Ocean coast between 1820 and 1824, acknowledged the great accuracy of Laptev's maps and geographical coordinates. His own measurements differed from those of Laptev by only 1-4 minutes, though the latter had much less precise instruments at his disposal.

So almost ten years of tremendous human efforts in severe climatic conditions brought brilliant results. Firstly, the northern group drew up accurate maps based on astronomical measurements of the previously unknown coastal strip from Arkhangelsk to Cape Bolshoi Baranov; explored the inaccessible inner regions of the Taimyr and Chukotka Peninsulas; discovered dozens of islands; investigated the outlets from the Anadyr basin into the Sea of Okhotsk; explored and charted the lower reaches of all the largest rivers and many of the medium and smaller ones. As a result

the world unexpectedly expanded by 140 degrees of latitude.

Secondly, the explorations of the northern group, which laid the foundations for the scientific study of the northern regions of Asia, had a direct bearing on the future organisation of polar navigation by showing the real difficulties of using the north-east passage around Siberia to the Pacific Ocean and ways of overcoming them. Although the detachments in the northern group failed to accomplish in full their mission of navigating the entire sea passage up to and including the Bering Strait, the vast quantity of maps they compiled and their notes on natural conditions, resources and the life of the local population fully justified all the sacrifices and expense involved.

The second assignment of the Great Northern Expedition was to find a sea route from Kamchatka to Japan and to establish the distance between Kamchatka and America. Below we shall discuss the results of M. P. Shpanberg's three voyages to Japan.

In 1738 Shpanberg's detachment consisted of three ships. Shpanberg himself got down to latitude 46° North on this voyage and thus only reached Vries Strait to the south of the isle of Urup. His assistant Valton, however, got somewhat further south, reaching the latitude of the Nemuro Peninsula in the northern part of Hokkaido.

The following year Shpanberg repeated the journey, this time with four vessels. Entering the sea from the mouth of the Bolshaya River in Kamchatka this fleet sailed along the Kuril Islands as far as the fourth island* and then headed south-east where the European maps of the day depicted the Great Land of Juan da Gama, which was said to have been discovered there by the Portuguese navigator Juan da Gama. The expedition investigated the supposed location of the Great Land and then the ships approached the island of Honshu which they rounded close to the shore. They did not land here, but continued south, disembarking somewhere in the southern part of the Gulf of Sendai. Here some Japanese brought out gifts to Shpanberg's ship. The Russian sailors presented gifts in return which, it seems, delighted the local inhabitants.

* In the 18th century the small island of Makanrushi situated between the islands of Paramushir and Onekotan in the Fourth Kuril Strait was usually known as the fourth island of the Kuril Ridge.

Lieutenant Valton sailed considerably further south (down to latitude 35° 10' North) on his vessel. Here he put into shore for water and thus his party became the first Russians to visit Japan. After firing a salute they continued to the south. "All marvelled at the profuse, luxuriant vegetation, which is not to be seen in Russian latitudes," Valton noted, "but for lack of time it was not possible to examine all of it." Valton determined that the furthest they sailed to the south was latitude 33° 28' North.

In 1741 Shpanberg made another attempt to reach Japan, but only got as far as the Gulf of Sendai, where they had been the previous year. This completed the explorations of Shpanberg's group to the Kuril Islands and Japan.

Shpanberg's work did not receive the credit it deserved from his contemporaries. As we look back objectively on the results of his explorations, we can claim with no little conviction that he and his assistants first showed conclusively that there was no land to the east of Kamchatka and Japan, as depicted on the majority of European maps of the day (e. g., the Land of Iesso, the Land of Juan da Gama), but an unbroken string of islands—the Kurils, stretching from the south of Kamchatka down to Japan.

The second naval detachment of the Great Northern Expedition, which Bering himself commanded, was given the task of establishing the real location of America, which was believed to be situated somewhere to the east of Kamchatka. In the early summer of 1741 two vessels—the *Svyatoy Pyotr* (Saint Peter), commanded by Bering, and the *Svyatoy Pavel* (Saint Paul), under A. I. Chirikov's command, set sail from Petropavlovsk Harbour on the Gulf of Avacha (Kamchatka Peninsula) for the New World. This voyage, which led to the discovery of the north-west coast of America, proved to be the most famous of all the explorations undertaken by the Great Northern Expedition in the north and far east of Russia.

Nine days after they left the Gulf of Avacha the ships reached latitude 46° North (June 13) without seeing any signs of "the land discovered by Don Juan da Gama". The ship's council therefore decided to change course to the north-east. On June 18 Bering, fearing that not everything had been done to fulfil their instructions to find the Land of Juan da Gama, suggested to Chirikov that they "go against their previous decision" and head south once more.

Chirikov refused and the vessels continued on the same course until June 21 when they lost each other in thick fog. The two ships continued to seek the "American shores" independently. Chirikov headed due east and only changed course to the north-east in early July. At 2 o'clock in the morning of July 15, 1741 the crew of the *Svyatoy Pavel* sighted land which "by its position, latitude and longitude... we recognise as the real America", as was noted in the log-book of the packet-boat *Svyatoy Pavel* (published by D. M. Lebedev), a copy of which is preserved in Soviet archives. Analysis of the notes in the log-book and calculations of the *Svyatoy Pavel's* route near the American coast carried out by D. M. Lebedev and First Officer G. K. Shumeiko suggest that when the ship discovered land, it was situated not far from Bartholemew Cape. The ship's crew also spotted Cape Addington and Forrester Island, that is "the region adjoining the Prince of Wales Island". Chirikov attempted to make a landing on the coast, but the party led by A. Dementyev and ten other seamen did not return. Six days later Chirikov sent four crew members out in a boat to search for the missing party, but when they also failed to return, the ship's council decided on July 25 that they should turn back to Kamchatka. After this Chirikov sailed west-north-west in sight of the American coast until August 1 and not far from the southern tip of the Kenai Peninsula, which they themselves had discovered, changed course to south-west and then to west (August 15). The Aleutian Islands were in sight at this time. Chirikov fixed the positions of a number of islands whilst they sailed through the straits between them. On September 9 he sailed close by Adak Island and on September 21—past Agattu Island, beyond which Attu Island was visible on the starboard side. Towards the end of the voyage many of the crew died from scurvy and Chirikov himself was in a critical state. Only their return to the Gulf of Avacha saved him from inevitable death. Loins de L'Isle de la Croyère died on October 11, 1741, as he was being carried ashore; 23 other members of the crew had died during the voyage.

The voyage of Bering's *Svyatoy Pyotr*, which approached the coast of America just 36 hours after Chirikov's vessel, ended even more tragically. On July 14, that is over a month out of Kamchatka, only one half of the ship's fresh water supplies remained and the land which Bering had

counted on finding by sailing south-east and south according to Joseph Delisle's map had not materialised. In view of this Bering called a ship's council where it was decided that they should change course and try to find land by sailing east-north-east. Two days later, just after noon on July 16, they caught sight of a peak on the starboard side. This was the St. Elias Mountain, the third highest in North America. The naturalist Wilhelm Steller of the Academy of Sciences, who was on board the *Svyatoy Pyotr* with Bering, recorded his first impressions of the land. He wrote that from the ship "one could delight in the view of magnificent forests and broad plains at the foot of the mountains. The shores were flat and, as far as one could judge, sandy". Over a period of six weeks (up to the end of August) Bering discovered off the coast of America the islands of Koyak, Kodyak, Tumanny, which was renamed Chirikov Island, the Yevdokeyev Islands and the Peninsula of Alaska. On August 29 islands were discovered off the south-west tip of Alaska. These were named the Shumagin Islands in memory of the sailor Nikita Shumagin—one of the first scurvy victims on board the *Svyatoy Pyotr*—who was buried here. As before Steller went ashore here and made observations of the climate and vegetation.

Steller's observations are diverse and interesting, for besides describing the natural conditions of America and the Aleutian Islands he gave his impressions of the population and the occupations they pursued. His diary, however, was only published some fifty years after his death—in 1793 in St. Petersburg. Steller's works, in particular the description of the journey to America, have also been published in Russian during the Soviet period.

In these works Steller gave a graphic and vivid description of the outward appearance and way of life of many of the marine animals which he observed during the voyage and their enforced stay on Bering Island in winter. Among them were the sea-cows (*Rhytina Stelleri*) which became extinct at the end of the 18th century.

On the Shumagin Islands Russian sailors first came into direct contact with the indigenous population of America — the Aleutians. The information on this people brought back by Steller, S. Vaksel and S. Khitrovo was the first on the aborigines of the north-west coast of America.

After visiting the Shumagin Islands the *Svyatoy Pyotr* set

sail for Kamchatka and in 15 days of sailing covered a distance of almost 1,000 kilometres. But on September 15 they unexpectedly ran into a raging storm. In Steller's words the ship was hurled "by God's will, wherever heaven in its anger directed us. One half of the crew was ailing and helpless; although the rest were able to work, the waves and rocking of the ship drove them to despair.... It was impossible to cook meals.... Courage deserted everyone of us and there was nothing we could think of to relieve our plight... Please do not think that I exaggerate the danger of our situation; I know that the most eloquent pen would be powerless to describe the horror of our plight."

By October 18 the ship had been carried back eastwards to approximately the same region near the Shumagin Islands where they had already been. On that day Vaksel and Khitrovo noted in the ship's log that 33 of the crew were sick, among them Bering himself. The ailing captain was replaced on the bridge by Lieutenant Vaksel and his assistant Khitrovo. Maritime historian A. Sokolov has described the state of the expedition in these words: "The long-suffering ship was in an extremely grave situation. They had almost lost their dead-reckoning or at least their calculations differed considerably from one another, the ship drifted with hardly any steering. Their commander was sick and had not left his cabin for a long time; there was disagreement among the officers who were trying to fight off the effects of illness; the crew was exhausted and dying from scurvy—at the rate of one or two a day.... There was neither hard tack, nor wine, and very little water. The weather was cold and damp. There was doubt, despair and fear of almost certain death...." It was therefore difficult to convey the joy which they felt when at 9 o'clock in the morning of November 4 the cry went up that land had been sighted. All the sick crew members, including Bering, came up onto deck. "The land ahead looked like Kamchatka, but as a barren, low-lying, forestless coast appeared on the horizon instead of the familiar mountain panorama" with the snow-capped peak of Mountain Avacha, "joy once again gave way to despair". Vaksel, Khitrovo and some of the crew insisted that they land immediately on what later turned out to be a desert island. On the following day they began disembarking—a task which they completed on November 22. According to Steller's observations the island was inhabited

by numerous sea otters, polar foxes and ptarmigans. A good deal of fresh food became available and many of the sick began to recover. But for the weakest of those afflicted succour had come too late. Among them was Bering, who died on December 8, 1741.

With the arrival of spring, when vegetation began to form part of the survivors' diet, the last traces of scurvy disappeared. To continue the voyage in search of Kamchatka they had to build a new ship from the remains of the wrecked *Svyatoy Pyotr*. The new ship, which bore the same name, was only completed on August 10, 1742. Three days later it set sail under the command of S. F. Khitrovo. On the morning of August 17 the watch caught sight of land. No one doubted that this time it was Kamchatka that they could see. And indeed on the fourth day of the voyage they dropped anchor in the Gulf of Avacha. Only on June 27 of the following year did the travellers reach Okhotsk, from where one year earlier Chirikov had left for St. Petersburg.

As we have already mentioned, one of the Great Northern Expedition's special assignments was to resolve a number of purely scientific problems which were drafted in the form of a special decree. This decree foresaw the need to gather materials on the history and geography of Siberia. A special detachment was thus required for the expedition and the Academy of Sciences was commissioned to recruit people for it.

The Academy assigned three professors to the expedition: I. Gmelin, a naturalist and botanist; G. Miller, a historian, and W. Steller, a zoologist and doctor of medicine. Gmelin and Miller, who were both young and extremely keen scientists, were happy to accept the assignment and, as subsequent events showed, were capable not just of fulfilling their mission, but of directing the work and study of their young assistants among the Russian students. One of them—S. P. Krasheninnikov, who is famous for his geographical investigations in Kamchatka, became the first Russian geographer-academician on his return from the expedition. From the scientific point of view the detachment was as well equipped and in some respects better equipped than other scientific expeditions of the day. The professors had at their disposal a large number of astronomical, geodesic and physical instruments. The scientific members of the expedition were empowered to use all the documents kept in

local archives, as well as those in the possession of the local administration.

During its investigations the Academy detachment covered vast territories in the south of Siberia and in some parts of the north. Miller and Gmelin made most of their journeys together. In 1740, however, Miller travelled alone along the Ob to Berezov, whilst Gmelin crossed the south of Siberia, following a line of latitude of approximately 50° North. Quite often they stopped in the same villages. Miller, who concerned himself with the survey, study and copying of documents in the archives and voyevoda chancelleries, spent a good deal of time in the villages. At the same time Gmelin and his student assistants V. Tretyakov and S. Krasheninnikov made a number of independent journeys radially from the villages and each time met up again with Miller at their base. For ten years they journeyed across Siberia in this way, only returning to St. Petersburg at the beginning of 1743.

During a journey up the river Irtysh Gmelin saw for the first time the forest-steppe landscapes of the West Siberian Plain—the largest plain in the world. Observations made on the journey of 1734 and later on the journey of 1741 further north approximately along the line of the present Trans-Siberian Railway enabled Gmelin to describe in detail the natural differences between the West Siberian Plain and mountainous Eastern Siberia.

By the very nature of its relief Western Siberia seems in fact like a direct continuation of the plains of European Russia and the exact antithesis of the elevated Central Siberian Plateau with its numerous big and small valleys. Whilst on average the height of the land fluctuates between 500 and 600 metres and Gmelin had every reason to regard its relief as mountainous, the highest points of relief in the extreme south of Western Siberia, at a distance of 2,000 kilometres from the coast reach only 150 to 200 metres above sea level. The damp, dark forests to the west of the Yenisei, which are often marsh-ridden and contain a few Siberian larch, give way to the east of the river to dry, light forests (especially to the south of the lower reaches of the Angara) where the Siberian larch is replaced by Daurian. Mixed with the light-requiring and dry-loving pine they form the clean, light and park-like forests which Gmelin saw there. To the north, in the Yakutsk taiga Gmelin noted larch forests of

a new type—marsh-ridden, oppressed, sparse forests with an admixture of poplar, asp and birch which, as we now know, stretch further to the east, far beyond the Lena. Their existence is dependent on the permafrost soils which cover almost the whole surface—conditions to which the Daurian larch has also adjusted. We have since learned that there are also fundamental differences between the fauna of Western and Eastern Siberia: the Yenisei marks an important natural boundary beyond which the majority of European species present in Western Siberia disappear. At the same time the typical East Siberian species are likewise not found to the west of the Yenisei. Thus Gmelin's principal ideas about the geographical distribution of fauna are in fairly good agreement with those of modern science.

We can also attribute to Gmelin a number of conceptions about the basic structure of Siberia's mountain relief and the names of the main mountain systems.

Some sixty years ago it was thought that the Stanovoi Range ran in an east-west direction from Lake Baikal to somewhere near the Gulf of Uda on the Sea of Okhotsk, then turned north along the coastline. This range is now known as the Dzhugdzhur Range. Gmelin's idea that it stretched north-east to Chukotka Peninsula (he did not have the data to make such a judgement that we possess today) was, in principle, absolutely correct. This shows that the Russian people whose information he used to draw his conclusions about the orography of Transbaikalia and north-east Asia were correct in their views. For this very reason Gmelin, by combining their judgements with his own observations, was able to make the correct scientific generalisations in the first half of the 18th century.

While Gmelin and his student S. P. Krasheninnikov made observations of nature, Miller whilst concerning himself with the purely historical problems assigned to him also spent a great deal of time collecting archive material on natural resources and the history of geographical discoveries which Russian land explorers had made in Siberia. This particular aspect interested the scholar so much that he often returned to it in his numerous works. It is thanks to copies of archive documents made by Miller that we know many facts about the discovery of Siberia, in particular Dezhnev's voyage from Kolyma round the Chukotka Peninsula to the lower reaches of the Anadyr and to the south.

The Russian students assigned to the Academy detachment were instructed by Gmelin or Miller to carry out independent investigations or were involved in copying documents. Krasheninnikov excelled in this field. With his excellent knowledge of Latin (the international language of science in those days) Krasheninnikov worked constantly as Gmelin's translator. As a result a friendly working relationship developed between them. Both Gmelin and Miller had a very high opinion of the talented young student who successfully carried out all their scientific commissions.

In January 1737 the Academy detachment left Irkutsk for Yakutsk, where on the instructions of the Academy they were to meet up with Bering and go on with him to Kamchatka to continue their research. Miller and Gmelin arrived in Yakutsk equipped with a thorough knowledge of Siberia. But the years of travelling through once unknown parts of the country had wearied them. When the academicians learnt from Bering that he was not able to provide the Academy detachment with a special vessel needed for their journey to Kamchatka, nor provisions on Kamchatka itself, they decided to send Krasheninnikov on alone. After seeing him off on July 9, 1737, they left Yakutsk almost immediately: Miller went to Irkutsk, where he worked on archives, whilst Gmelin spent the winter in the Kirensk Fort. Here he put into shape the notes of his observations. On his way to Yakutsk he made meteorological observations, processed his herbal collections and began work on his fundamental work *Flora sibirica, sive historia plantarum Sibiriae.*

It is interesting that in his later recollections of the early years spent in Siberia Krasheninnikov spoke very highly of Gmelin as a man, a teacher and a scientific leader. Thanks to his close scientific relationship with Gmelin Krasheninnikov became the author of the highly commendable scientific paper *Opisaniye Zemli Kamchatki* (Description of the Land of Kamchatka). The personal qualities of Krasheninnikov himself, who in Lomonosov's words "immediately distinguished himself by his abilities and zeal for science", undoubtedly played an important part in his work.

Krasheninnikov's 1,337 days of work in Kamchatka (from October 14, 1737 until June 12, 1741) was a tremendous achievement by the young Russian scientist. Even on the journey from Okhotsk to the Bolsheretsk Fort in Kamchatka the old vessel *Fortuna* in which he was sailing

began taking in water. The passengers and crew threw overboard the first things that came to hand in an effort to lighten the vessel. As a result Krasheninnikov lost his provisions and personal belongings before he arrived in Kamchatka. The bread brought from Okhotsk did not last very long; his staple diet, like that of the local population, became fish whose odour he detested from then until the end of his life.

But the work went on and, moreover, yielded brilliant results. In his winter and summer journeys across Kamchatka Krasheninnikov with the assistance of the Cossacks assigned him by the Bolsheretsk authorities carried out a whole complex of "various kinds of observations concerning natural history", collected materials on the history of the discovery and acquisition of Kamchatka "with all the relevant circumstances", observed and described the life and customs of the local population and also compiled dictionaries of the languages of the peoples inhabiting this land. He was virtually an entire multi-purpose expedition in himself.

During his time in Kamchatka Krasheninnikov and his assistants made nine major journeys, criss-crossing the peninsula from Cape Lopatka in the extreme south to the river Karaga in the north.

We are indebted to Stepan Krasheninnikov for the first reliable and detailed description of Kamchatka, which for more than one hundred years after its publication in 1756 remained the only scientific study of this outlying territory of the Russian State. His encyclopaedic work embraced all aspects of the natural environment, as well as history, ethnography and, to some extent, the languages of the peoples of Kamchatka. It is the first monograph on the geography of Kamchatka in the history of the study of Siberia. Krasheninnikov's observations in Kamchatka, which form the basis of his work, are extremely accurate. One can only marvel at his ability in seeing and grasping everything around him. This is perhaps why in the extensive and diverse literature on Krasheninnikov and his *Description of the Land of Kamchatka*,* which has been published for over two centuries

* A bibliography of this literature is given in the Academy's edition of *Description of the Land of Kamchatka*, which was prepared and published in 1949 with the cooperation of the Institutes of Geography and Ethnography of the USSR Academy of Sciences and the State Geographical Society, and in an English translation published in the USA,

both in Russia and abroad, it has often been pointed out that this work is unsurpassed in its exhaustive scientific complexity and authenticity. If we did not now have his books at our disposal, much of what we know about the history and economy, not to mention the ethnography of Kamchatka and the three northern Kuril Islands would be unknown to science.

Let us examine two examples which demonstrate the accuracy and authenticity of Krasheninnikov's observations. Whilst making a journey across Kamchatka in 1739 he discovered and described the only place on the peninsula where silver fir can be found. To this day silver firs are known only in the region where Krasheninnikov found them—in the bay and along the valley of the river Semyachik. Not far from here he discovered geysers, which he described in some detail. But after this not one of the explorers investigating Kamchatka confirmed Krasheninnikov's reports and, moreover, they all rejected the possibility of geysers being present on the peninsula. In 1941, however, T. I. Ustinova not only confirmed Krasheninnikov's observations, but discovered new geysers in the region he had described. On June 12, 1741 Krasheninnikov left Kamchatka and 12 days later arrived in Yakutsk. From here he proceeded to Irkutsk. After being sent for by Gmelin, he joined up with his teacher in the Urals in December 1742. In February of the following year Krasheninnikov returned to St. Petersburg with Gmelin and Miller after an absence of almost ten years.

In the capital students Krasheninnikov and Tretyakov were set an examination by the conference of academicians. Krasheninnikov successfully fulfilled the task set him in Latin. After this he was awarded the title of "student of natural history". Three years later, on July 26, 1746, he received the title of an adjunct of natural history at the same time as Lomonosov was confirmed by Senate Decree in the title of professor (academician). In May of the following year Krasheninnikov was given a new assignment—that of looking after the botanical gardens. At the same time they commissioned him to sort out and put in order the notes, diaries and all kinds of papers which he had given Steller in Kamchatka. These documents formed the basis of the monograph he wrote about Kamchatka which the Academy

namely S. P. Krasheninnikov's *Exploration of Kamchatka.* Translated with Introduction and Notes by E. A. P. Cronwert-Vaughan, Oregon Historical Society, Portland, 1972.

of Sciences published in 1755. Krasheninnikov signed the proofs of his book just a few hours before his death. Steller also wrote a book on Kamchatka which was first published in German (Frankfurt, 1774). This book, which was similar in content to Krasheninnikov's, gave rise to some controversy outside Russia in the 18th century, during which Krasheninnikov was accused of using Steller's material. This view was refuted, however, in 1775 by a number of German scholars. Analysis of the two authors' materials carried out by a number of researchers (including V. I. Grekov in recent times) has shown that it was in fact Steller who used the materials which Krasheninnikov gave him in Kamchatka, and the completed sections which later went into Krasheninnikov's book. In particular the text of the chapter on the vegetation of Kamchatka in Steller's book matches precisely the Latin original of Krasheninnikov's manuscript *Opisaniye ptits, ryb, zhivotnykh i rastitelnosti* (Description of the Birds, Fish, Animals and Vegetation) found in the archives of the USSR Academy of Sciences.

Despite certain shortcomings and errors the scientific results achieved by the Great Northern Expedition were of immense significance and to this day strike one by their multiformity and diversity. The expedition revealed for the first time the natural conditions and resources of Siberia, and the history, ethnography and economy of the peoples inhabiting it; it found passages to America, the Kuril Islands and Japan; discovered the Aleutian and Komandorskiye Islands; ended for once and all the legend about fantastical lands situated in the Pacific Ocean between Japan and the Kuril Islands, and between Kamchatka and America. In the history of Russia its navigators made a whole era full of heroic exploits by exploring and charting for the first time almost the entire Arctic and Pacific Ocean coastlines of the Russian State from Arkhangelsk to the mouth of the Uda and the Shantar Islands, and along the shores of Sakhalin to the La Perouse Strait.

The materials obtained by the expedition formed a basis for the unprecedented amount of scientific publications and maps of Siberia which appeared at that time. The Academy's atlas of 1745 used these maps for its depiction of Siberia. Apart from Krasheninnikov's book on Kamchatka these publications included such major scientific works as *History of Siberia*; *Description of Voyages Across the Arctic and East-*

ern Seas Made from Russia; *Information on Trade in Siberia* and other of G. F. Miller's historical works and papers on the history of geographical discoveries economy and geography; *Siberian Flora* and *Journeys in Siberia* by I. G. Gmelin. In addition to Steller's book consonant with Krasheninnikov's *Description of the Land of Kamchatka* a number of works by Steller describing the animal world of the northern Pacific Ocean and the natural conditions of north-west America, the Aleutian Ridge and Bering Island, and his diary and description of the journey made with Bering which were published in St. Petersburg and outside Russia between 1751 and 1793.

Such is the general scientific result of the work of the Great Northern Expedition which gave a tremendous boost to the development of geographical science and knowledge in Russia and set it alongside those countries in which geography, by virtue of its deep roots and long history, had long before achieved fame and recognition.

THE GEOGRAPHICAL DEPARTMENT OF THE RUSSIAN ACADEMY OF SCIENCES

The general assignments which Peter I set the Academy of Sciences of correcting old and drawing up new geographical maps soon acquired more clearly-defined outlines, namely the compilation on a scientific basis of a general map and general geographic atlas of Russia. The Academy's astronomical, geographical and cartographical work was directed by Joseph Delisle, whose activity received contradictory assessments in scientific literature.

Along with a whole range of works on the scientific theory and methodology of astronomy and geography we must number the following achievement made by Joseph Delisle when he was in the service of Russia: the organisation of an astronomical observatory, which his contemporaries judged to be the best in Europe, and astronomical observations; the organisation of the first triangulation work (1737); the creation of an extensive cartographical fund which formed the basis for the Geographical Department's unique collection of maps; the formulation (1732) of a plan to set up the Geographical Bureau; the verification, systematisation and description of primary cartographic materials; the elaboration of a mathematical basis for the general maps

of the 1734 and 1745 atlases and substantiation of the selection for these maps of two-standards conical equidistant projection (Delisle's Projection). The astronomical and cartographical expedition which he led to Beryozov (1740) obtained results of considerable practical and scientific significance.

However, despite their scientific value his proposals on the compilation of an atlas of Russia took absolutely no account of either the urgency of satisfying the state's need for geographical maps, the extent of Russian territory and the irregular way the geography and cartography of its individual regions had been studied, or the special difficulties of determining the position of geographical points from astronomical observations and training qualified geodesists.

The development of the work on the atlas can be divided into two main periods: from 1726 to 1740, and from 1740 until 1745.

Through the whole of the first period Delisle concentrated his projects, instructions and proposals on developing an extensive programme for combining astronomical-geodesic and cartographical work, centralising the management of cartographical work and improving the training of personnel. The project which Delisle formulated and published in 1727 helped place geodesic work in Russia on a scientific footing, and in 1728 he developed a scientific methodology for compiling a review map. The instruction which he drew up in 1738 for geodesists won the approval of the eminent Russian geographer V. N. Tatishchev and Naval Academy professor A. D. Farvarson.

From 1737 onwards Delisle gradually dropped his cartographical work and in the following year the Geographical Bureau, whose staff included Professor L. Euler, Professor P. Lerua and architect K. Shesler, ceased its activity.

The transformation of the Geographical Bureau into the Geographical Department in 1739 was initially aimed at bringing a speedy conclusion to the protracted work on the atlas. During the concluding stage of the work in 1740 and 1741 the Department was headed by the eminent mathematician L. Euler, and subsequently by Academicians Heinsius and Winsheim. From 1735 onwards the proceedings of the Bureau draw attention to Euler's intensive activity in processing, systematising, editing and drawing maps. Later he performed major calculations to create a

mathematical basis for the atlas maps. The compilation of maps proceeded particularly rapidly after the Euler-Heinsius plan had been approved.

As distinct from Delisle's project this plan initially required that maps of provinces and gubernias, rather than a general map, be drawn up from district maps of varying scale. These then served as the basis for a review map. By 1742 eight regional maps had been compiled and Winsheim published a small prospect in which he set out in brief the plan and contents of the future atlas; Heinsius, meanwhile, published an article—"O sochinenii landkart" (On the Composition of Land Maps), which in almost unchanged form was later a part of the foreword to the atlas.

At last on September 2, 1745 Delisle presented the Academic Conference with the completed atlas published "for national usage". Its official title was the *Atlas of Russia, Consisting of Nineteen Special Maps Representing the Russian Empire and Border Lands, Compiled According to Geographical Laws and the Latest Observations With an Affixed General Map of That Great Empire, by the Endeavours and Works of the Imperial Academy of Sciences. St. Petersburg, 1745.* The Academy of Sciences thus marked a major scientific achievement for Russian geography and a cultural and political event of both national and international importance. Two versions of the atlas were published: in Russian and in Latin. The title page and the foreword were printed in Russian, Latin, French and German. The atlas reflected the extent to which the geography of Russia had been studied by the first half of the 18th century and was the first complete collection of maps of the Russian State compiled on a scientific basis. The atlas, which measures 52 by 32 cm, contains a general map of the Russian Empire with a scale of 200 versts to the inch (1 : 8,400,000), 19 regional maps and one inset (The Far Northern Shores of Siberia to the East—the Chukotka Peninsula). European Russia is depicted in 13 maps with a scale of 35 versts to the inch (1 : 1,470,000), whilst the Asian part is shown in six maps of 89 versts to the inch (1 : 3,738,000).* The smaller scale of the latter maps was chosen "to represent the whole of vast Siberia, in which there are very many empty spaces, on a smaller scale".

* According to other calculations the scale of the Siberian maps is 1:3,780,000 and that of the general map 1:9,534,000.

The regional maps did not cover strictly any one particular geographical or administrative area; this led to complications with the names of many maps. Map No. 5, for example, is called *Geographical Map, Containing the Smolensk Gubernia With Parts of the Kiev, Belgorod and Voronezh Gubernias,* whilst No. 7—*Little Tartary With the Bordering Kiev and Belgorod Gubernias, Including the Lands Near the Dnieper, the Don and the Donets, the Whole of the Crimea, and Part of the Kuban and the Black Sea.* The list of contents, however, provides a more complete description of each map and states its astronomical-geodesic basis.

The foreword to the atlas sets out information on the correlation between the general, special and regional maps, on the mathematical basis of the atlas and the methods used to form it. There is also a table of coordinates of 62 reference points (54 latitudinal and 8 latitudinal-longitudinal).

For the first time in the history of Russian cartography a system of conventional symbols was elaborated for the general geographic atlas. A particularly detailed classification was made of the settlements shown on the maps and among the conventional signs for copper, iron, sulphur and salt works, windmills, and battlefields, fortifications, military out-posts and ruins. As regards the representation of physical geographic features one is particularly struck by the detailed depiction of the hydrographic network; relief is represented by the traditional "hillocks", and forests by drawings of trees. The atlas is a unique historical and geographical source for studying the political and administrative division of Russia in the 1730s and 1740s.

The rich geographical content of the atlas was matched by the magnificent design of the maps, which were executed in the form of engravings (a part of the edition was hand-painted) from copper plates with clear prints and fine, well-defined lines. Cartouches with allegorical figures and realistic pictures conveyed fairly authentic information on the landscape, occupations of the local population, etc. The decorations were engraved by Academician Y. Y. Shtelin.

The Academy atlas naturally gives a more accurate picture of the territory of Russia than Kirilov's atlas of 1734. The instrumental surveys and geographical descriptions of the Russian geodesists, whom we have every right to call the chief co-authors of the *Atlas of Russia,* comprised the main source used for compiling the general and regional

maps. All the principal achievements of Russian cartography, including certain results of the Bering-Chirikov expedition, and the voyages of Shpanberg and Valton, the materials of the Georgian cartographer Vakhushti Bagrationi, and the polygonometric work of A. D. Farvarson and I. L. Lyuberas, were used as source material.

Contemporaries in Russia and abroad had a very high regard for the significance of the atlas. V. N. Tatishchev noted that its maps "surpass all previous works by virtue of their authenticity and fine composition". Academician G. F. Miller wrote that "other states, where science has been flourishing for hundreds of years, can hardly boast of such zeal in the compilation of their land maps". L. Euler also commented from Berlin that with the publication of the atlas the "geography of Russia ... has been put in much better order than the geography of the German land" and the maps were "much better than previous Russian maps and were even far superior to German maps". The publication of the atlas was also welcomed by Jean d'Anville, the first geographer to the King of France and honorary member of the St. Petersburg Academy of Sciences, who noted that "if we waited for the time when such works achieved absolute accuracy, then society would obtain hardly anything". Despite the fact that many geographical maps of various regions were published in the 1770s and 1780s, the 1745 atlas did not lose its significance as a constant reference guide for many decades to come, as was evidenced by its reprinting in 1761 and 1785.

Today the *Atlas of Russia* is a fundamental historical and cultural monument to a whole era in the geographical study of Russia, and 1745 is, in the words of L. S. Berg, "one of the most important dates in the history of Russian geographical science. The whole significance of the Academy's work becomes clear if we remember that in the middle of the 18th century only France (thanks to Cassini) possessed an atlas similar to the Russian one".

The atlas, nevertheless, had a number of shortcomings. Contrary to the view of the majority of academicians that "numerous errors would result from hasty composition" the adviser to the academic chancellery, I. D. Shumakher, insisted on rapid publication of the atlas. Haste in publication precluded full use of such important materials as the results of the geographical study of Siberia undertaken by the north-

ern and academic detachments of the Second Kamchatka Expedition, the Naval Academy's final maps of 1742, and the maps, plans and geographical descriptions sent from Orenburg and the Urals by Kirilov and Tatishchev. G. F. Miller, who on his return from expedition in 1743 offered his services in eliminating some of the defects, found "countless errors" in the Siberian maps. Neither did they use all the materials gathered by the Geographical Department (e. g., I. I. Neplyuev's border surveys of 1740). Complaining about this, Lomonosov wrote that "after looking at the Geographic Archives of the day and at the atlas which it published, it is easy to understand how much more correct and accurate it could be", and emphasised that its "errors and imperfections are so great that not only are many wrong place names given and their locations falsely indicated, but notable areas omitted and whole populated districts absent". Tatishchev pointed out mistakes in the transcription of geographical names, the omission of the names of a number of geographical objects (rivers, lakes, mountains), and the absence of information on "inhabiting peoples". N. I. Kozhin compiled a manuscript geographical explanation to the atlas in answer to the compilers' request to take part in correcting and supplementing it. Expert scrutiny of the atlas was undertaken by Jean d'Anville who dealt mainly with inaccuracies in the positions of towns and the courses of rivers in border regions of Russia. The compilers themselves were fully aware of the atlas's shortcomings. They declared in the foreword that "this work has not reached complete perfection", giving the main reasons for the defects as the absence of authentic information on the coordinates of reference points and satisfactory specialised maps. It is not surprising therefore that the President of the Academy, K. G. Razumovsky, proposed in 1746 that the Geographical Department begin work immediately on a new atlas of Russia.

Some 25 cartographic works appeared between 1726 and 1745, the year in which the *Atlas of Russia* was published. These were: three maps for I. K. Kirilov's atlas, I. G. Gerber's map of the western coast of the Caspian Sea (in Latin), 10 maps of military actions, a plan of St. Petersburg, the world *Atlas Compiled for the Benefit and Use of Young People* of 1737, the first geodesic plan of Moscow (1739), and a series of plans, maps and charts of the Baltic and Gulf of Finland coasts.

The relatively weak development of cartographical work in the Academy after the publication of the *Atlas of Russia* (between 1746 and 1757) should be regarded not just as a consequence of the generally unsuccessful activity of the heads of the Geographical Department (C. N. Winsheim, succeeded by astronomer A. N. Grishov and G. F. Miller) and troubles within the Academy, but more as the result of successive curtailment of geodesic surveys and a sharp reduction in the publication of new maps and the influx of geographical materials. In 1753 the Geographical Department published a plan of St. Petersburg to mark the fiftieth anniversary of the capital's foundation. The following year it issued five maps of the continents and hemispheres, which in 1757 were combined into a single world atlas.

Apart from filing and analysing reviews of the *Atlas of Russia* Winsheim prepared a systematic list of the collection of manuscript maps begun by J. N. Delisle. This bibliographical description of maps appeared in 1748 under the title "Register of the Land Maps, Charts and Plans of the Russian Empire, Kept in the Geographical Department of the Academy of Sciences". The Register reflected one more function which the Department performed—the collection, accumulation and custody of cartographical sources. It listed 564 manuscript maps. I. F. Truskott, who continued this work from 1773 to 1785, listed some 1,100 maps.

Despite the general slump in the compilation of maps the work of G. F. Miller on the cartographic collation of the results obtained from the study of Siberia met with a significant response outside Russia. In his autobiography he wrote the following: "When in 1752 Monsieur Delisle published in Paris information and a map on the American voyages made by the Russians during the Kamchatka Expedition, which bore little resemblance to the truth, a decree was sent to the Academy from Moscow to refute that work by the publication of another, more substantial." The implementation of this decree fell to G. F. Miller himself who, like L. Euler, F. I. Shubert and many other scientists from Western Europe employed in the Russian service made a considerable contribution to the development of Russian science.

Carte Génerale des Découvertes de l'Admiral de Fonte et autres Navigateurs espagnols, anglois et russes pour recherche du Passage à la Mer du Sud, appended to J. N. Delisle's article Explication de la carte des nouvelles dé-

couvertes au nord de la mer du Sud" (1752) was inserted with a few changes in his atlas of 1753. In an attempt to bring the Russian discoveries of Chirikov, Shpanberg, etc., into line with the fantasies of Admiral de Fonte the author relied on much unauthentic data (including the materials of de L'Isle de la Crouyére who took part in the Kamchatka Expedition). G. F. Miller refuted the works of Delisle by compiling his general map of Siberia in 1746 as a correction to the atlas of 1745. In 1754 he completed an original map of new discoveries under the title *Nouvelle Carte des Decouvertes faites par des Vaisseaux Russiens....* Four years later the map of discoveries was reprinted with certain corrections and additions and became well known in the cartography of Western Europe. Lomonosov managed to have this map published in French, and in 1761 included it in the list of additional maps for the reprinting of the *Atlas of Russia.* I. F. Truskott, an adjunct student of the Geographical Department, took part in compiling the maps of 1754 and 1758. In 1773 he produced a reworked publication "Maps Representing the Discoveries Made by Russian Navigators in the North of America and Nearby Places". The text of G. F. Miller's refutation appeared abroad in 1753 as an anonymous *Lettre d'un Officier de la Marine Russienne....* An explanatory note to the maps of the 1754-1758 period appeared in Russian and German and was soon translated into English and French.* Miller's works re-established the leading position of Russian explorers in the study of North-East Asia, North-West America and the Pacific Ocean (the voyages of Dezhnev, Gvozdev, Bering and Chirikov) and gave geographical science authentic information on these distant regions. Nevertheless the fantastic pear-shaped outline of the Chukotka Peninsula and other inaccuracies on the map of 1758 prove that Miller was unaware of the Naval Academy's final concluding general maps of 1746, which gave more accurate contours of the Russian Empire's northern and eastern coasts.

In this same period Miller compiled a new general, so-called postal map of Russia, which was only published in 1771. Under his guidance I. F. Truskott completed (1764)

*. In 1967 a facsimile edition of the English translation was published in the series Bibliotheca Australiana (G. F. Müller, *Voyages from Asia to America for completing the discoveries of the north-west coast of America* ..., London, 1761).

a map of the Orenburg gubernia which appeared in 1772. Three maps of Kamchatka borrowed from Miller's master map of Siberia of 1746 were supplemented to Krasheninnikov's book (1775). But despite these works Miller, who performed the functions of both secretary of the academic conference and historiograph, took little part in the affairs of the Geographical Department. He considered geography and cartography as auxiliary disciplines for history. His chief scientific interests were therefore confined not to the vital questions of geography, but to toponymics and historical geography, not to problems of practical and mathematical cartography, but to the history of maps.

"Correction of the *Atlas of Russia* should always be the main purpose of the Geographical Department"—such was the view of Lomonosov, who in the last ten years of his life paid particular attention to developing the theoretical and practical scientific aspects of geography and cartography. A year before his official appointment as head of the Geographical Department (1758) Lomonosov, who had a complete grip on the state of affairs there, drew up a detailed plan to eradicate "the excesses, shortcomings and confusions" of the Geographical Department. For this he outlined three main areas where they should concentrate their attention: the organisational improvement of the Geographical Department, which performed particular functions of state importance; supplementing the staff of the Department with qualified Russian geodesists and cartographers; provision of accurate scientific data and authentic geographical information for map compilation.

In an instruction of October 3, 1757 Lomonosov laid down strict regulations governing the duties of the staff, organisational and methodological principles of map compilation. The instruction provided for joint discussion at weekly meetings of all theoretical, methodological and technical questions and progress reports on the work done; correction of the 1745 atlas in accordance with the most recent materials; introduction of a data-card system for maps; elimination of any hypothetical representations on maps which were not based on verified data; joint discussion and approval by a general meeting of the author's original of the map; systematic exposure, filing and storage of manuscript and printed cartographic source materials for map compilation.

Lomonosov kept a close watch on the recruitment and training of staff of the Geographical Department. He instructed Professors N. I. Popov and A. D. Krasilnikov to teach the students theoretical and practical astronomy, and adjuncts Y. F. Shmidt and I. F. Truskott to lecture on cartography. Four school-leavers who entered the Department on Lomonosov's insistence in 1762 received the title of geodesist four years later. Lomonosov noted with a great pride and satisfaction that Russian geodesists and students of the Geographical Department were for the first time in its history instructed in cartography and could compile maps independently, and that all the students could be used in any geographical work and would become worthy of the name of geographer. These geodesists included S. Nikiforov, K. Bashurinov, O. Polidorsky, and senior cartographer L. Tersky, who worked successfully in the Department for several decades.

Lomonosov took active steps to improve the mathematical principles on which maps were based. His plans for geographical expeditions to study Russia and make astronomical measurements, set out in a report of October 18, 1759, in his *Mneniya* (Opinions) on the sending of astronomers "to the most essential parts" of Russia to determine the latitudes and longitudes and on geographical expeditions (1760), and in the *Primernaya instruktsiya* (Exemplary Instruction) of 1764, were not implemented at that time. Like many of his other remarkable ideas and undertakings they were only put into practice after the great scientist's death. We should regard the voyages of V. Y. Chichagov (1765 and 1766), the academic expeditions of 1768 to 1774, and the astronomical expeditions of I. I. Islenyev (1768-73) and P. B. Inokhodtsev (1781-85) as directly fulfilling Lomonosov's precepts.

Lomonosov, who realised full well that "maps do not consist of projections alone", attached great importance to improving their geographical content. "For this," he wrote, "one needs to know the location of places, the course of rivers, the contour of coastlines, the position of islands, lakes, towns and the like. Without that, however good the projection, one can make maps like Schlaraffenland, that is place Astrakhan in the Kola Peninsula, Kronstadt in Lake Onega." A fierce opponent of depicting "fairy-tale countries" on maps, Lomonosov worked out in 1759 a questionnaire for gathering information on physical and economic geog-

raphy. By 1764 the Geographical Department had collected four volumes of replies from places which gave "detailed topography ... for half the state". Lomonosov's *Opinion on the Use of the Current Revision for the Benefit of Russian Geography and the New Atlas Being Compiled* (1764) pursued a similar aim.

Apart from publishing the Miller-Truskott map of 1758 and the plan of Moscow of 1763 the Geographical Department prepared for publication 12 general and special maps of the Baltic coast and Siberia (worked up by Y. F. Shmidt and I. F. Truskott) between 1758 and 1765. Lomonosov's work in the field of economic geography was closely linked with cartographic problems. In 1763 he presented a plan for an *Economic Lexicon of Russian Products* for which the Department prepared two base maps. Lomonosov was not just a talented organiser and director of the work of the Geographical Department, but the author of many cartographical works. The most significant of these were an original "polar-circle" map of the Arctic (1757) and the first Russian school globe, 1,000 pieces of which were made at his own expense.

Lomonosov was succeeded as head of the Geographical Department by Y. F. Shmidt and I. F. Truskott (1765-68), then by L. Euler (1769-83) and his pupils S. Y. Rumovsky (1769-86) and F. I. Shubert (1786-99).

In view of Russia's economic development in the latter half of the 18th century there was a vital need for an intensive study of its geography and the developing economic interrelations between its different regions. These requirements were met by the Department during the period from 1766 to 1786. This exceptionally fruitful period saw, on the one hand, the development of Lomonosov's creative heritage and, on the other, the interpretation of the valuable results obtained from the multi-purpose academic expeditions and new accurate astronomical work of the last thirty years of the 18th century.

During this period the Geographical Department issued 148 maps, of which 58 were appended to various scientific publications. Among these were military maps in works on military history; maps and plans on various aspects affixed to the essays, notes and diaries of travellers I. E. Fisher, N. P. Rychkov, P. S. Pallas, S. G. Gmelin, I. G. Georgi and I. P. Falk; and maps of discoveries for the journal

Mesyatsoslov geograficheskii (Geographical Calendar). In 1773 a pocket-atlas consisting of 13 maps based on the 1745 atlas appeared as an appendix to L. I. Bakmeister's *Kratkaya Rossiiskoi imperii geografiya* (A Short Geography of the Russian Empire). A short atlas comprising eight maps of the Volga between Tver and Dmitrievsk was published in 1767 in connection with Catherine the Great's journey.

The majority of the 90 separate maps compiled in detail and with considerable accuracy was the work of the diligent and experienced scientist-cartographers Y. F. Shmidt, I. F. Truskott and I. I. Islenyev. The first maps published in the 1770s were those of the Baltic coast (the gubernias of Riga, Revel and Vyborg, and the Gulf of Finland), prepared by Shmidt under the watchful eye of Lomonosov. Shmidt also compiled geographical maps of the gubernias of St. Petersburg, Novgorod, Arkhangelsk, Pskov, Smolensk, Kiev and Mogilev, and maps of Moldavia and Walachia, the Crimea (1777) and the Orel administrative area (1779). Truskott drew up geographical maps of the Astrakhan gubernia, the Kuban and separate parts of Siberia; Islenyev prepared a series of maps of the Irtysh basin, and maps of the Novorossiisk, Novgorod and Azov gubernias.

Adjunct F. Cherny's map of the Kazan gubernia, appeared in 1779. Most of his work, however, belongs to the period after 1786 which saw the publication of his maps of the administrative areas of Nizhni Novgorod, Kursk, Vyatka, Vladimir, Ufa and Saratov, and his map of the Crimea (1790). In 1783 and 1784 A. M. Vilbrekht, who subsequently became one of the leading Russian cartographers of the late 18th and early 19th centuries, worked in the Geographical Department. He began his cartographical career by compiling two maps "representing the northern and southern hemispheres viewed from the poles".

For the 50th anniversary of the Academy of Sciences in 1776 Shmidt and Truskott published a general map of Russia (1:7,227,000) compiled "according to the most recent observations and information". With F. I. Shubert these same two cartographers drew up a three-page general map of Russia (1:5,250,000) in 1786, which reflected the changes in the administrative division. The *Historical Map of the Russian Empire* (1:11,536,000), which described the historical changes in the borders of the Russian State (1793), was one of the Geographical Department's last fundamental works.

The trend towards decentralisation of map compilation and publication first seen in the middle of 1760s strengthened by the end of the century. New institutions which directed special departmental work in surveying and cartography made their appearance. These included: the General Staff (1763), the Map Depository (1797), the Cadastral Survey Department (1765), the Geographical Departments of the Cabinet (1786) and of the Senate (1797), and the Map Depot of the Department of Waterways (1798). In these circumstances the Geographical Department of the Academy of Sciences lost its significance as a scientific centre of cartography—and in 1800 it was abolished. In 1805 the Engraving Chamber was also closed down.

Between 1726 and 1805 the Academy published 324 cartographic works, including several atlases and review maps of the state, and built up a collection of 790 manuscript maps and plans which formed a part of the most valuable possession of Russian cartography. The leading experts of the day—Delisle, Miller, Lomonosov, Euler, Rumovsky, Kotelnikov, Islenyev, Cherny and Shubert—all had a hand in creating these cartographic works.

Thus whilst geographical and cartographical investigations in the Academy of Sciences were carried on with varying intensity, during the years of its existence the Geographical Department always remained the organisational, methodological and scientific centre in the field of geography and cartography, the main cartographical institution in Russia, systematically compiling and publishing maps and instructing Russian students and geodesists in cartography. The Department played a particularly important part in developing the mathematical principles of Russian cartography and in collecting materials on the geography of Russia in the 18th century.

LOMONOSOV'S ROLE IN RUSSIAN GEOGRAPHICAL SCIENCE

The development of Russian science in the 18th century is inseparably linked with the great scientist and encyclopaedist Mikhail Vasilyevich Lomonosov (1711-1765). Lomonosov's theoretical propositions on the investigation of nature, his geographical works and his many years of activity as the

head of the Geographical Department of the St. Petersburg Academy of Sciences were of vital importance for the subsequent development of Russian geography.

A native of the White Sea region (he was born on Kurostrov, near Kholmogory) and son of a pomor peasant, Lomonosov had to overcome severe privations and obstacles on his road to science. In the Academy of Sciences Lomonosov worked to develop Russian science and culture, and was an advocate of education (Moscow University was founded on his initiative). He constantly strived to link science with practice and make it serve the needs of society. Lomonosov also made important theoretical discoveries in the field of natural sciences.

Lomonosov's views on geography as a science and on its main tasks rested on his materialistic philosophy, his theoretical approach to scientific cognition of the surrounding world, and his understanding of the significance of science for human society.

Lomonosov did a great deal in the field of geography during his years as head of the Geographical Department of the Academy of Sciences. Here he focussed his attention on developing the geographical exploration of Russia and collating information on the country's nature, economy and population. He also directed his efforts towards the training of geodesist-cartographers from among the Academy's students (at that time a secondary school and university were attached to the Academy). Lomonosov strove to carry out his intention to publish a new, improved *Atlas of Russia* and make Russian geography as accurate and reliable as possible. Of the many different works done in this field we can single out Lomonosov's "geographical questionnaires" and his geographical expedition projects.

The "geographical questionnaires", which contained thirty questions, were circulated on behalf of the Academy of Sciences in the gubernias and provinces of Russia in early 1761 in order to gather information on the geography of different parts of the country. A significant feature of the questionnaire was the inclusion of a number of questions on economic geography concerning towns, trades, factories, communications, population, sorts of grain sown and yields, etc. Lomonosov considered that all these questions were extremely important for geography. Among the topics covered by questions on physical geography were those concern-

ing rivers, mountains, and flora and fauna. These questions reflected Lomonosov's broad understanding of the tasks of geographical research and description.

This understanding was expressed just as clearly in the projects of geographical expeditions in Russia which Lomonosov formulated between 1759 and 1764. He considered that to compose a more accurate and detailed geographic atlas of the country than the *Atlas of Russia* of 1745 it was essential to organise large-scale explorations. This, he believed, was necessary both to gain scientific geographical knowledge of the country and to achieve the urgent practical aims linked with the needs of the state. Pointing out to the close link between investigations in the field of geography and practical needs Lomonosov started his note on geographical expeditions (1760) in the following way:

"Anyone with an understanding of national gains can judge quite easily how much benefit mankind derives from geography. The mere knowledge of the position of states and especially of one's own country brings great satisfaction to the heart. It would be much greater, if we could obtain from this knowledge real benefit for all and for ourselves."

According to the project, which is set out later on in the note, it was proposed to equip three expeditions to investigate European Russia, each of which was to make a journey of about 6,000 versts over a period of eighteen months to two years. Later slightly different versions were formulated, and in 1764 a set of instructions was drawn up for the members of the expeditions. The instructions outlined the work to be done on determining astronomically the latitude and longitude of various geographical points and on describing the geography of those territories to be investigated.

"Moving from place to place across dry land and water record the nature of the places: i.e., forest or field or mountainous terrain and so on. . . ."

"In towns, where observations should be made, put down everything that is required in the geographical questionnaires which have been circulated throughout the state. . ." "In towns, where latitude and longitude are to be determined, record meteorological observations. . ." "Keep an accurate diary throughout the journey. . ."

Lomonosov's plans for geographical expeditions whose implementation he pressed for continuously, were not carried

out by the Academy during his lifetime. But they laid the foundation for the organisation of the major academic expeditions between 1768 and 1774 which yielded excellent scientific results. The general purpose of these expeditions and the instructions which the Academy gave their members were linked historically with Lomonosov's projects.

Lomonosov also formulated a plan for a sea expedition, which under the command of V. Y. Chichagov attempted to discover a sea route along the northern coast of Russia. This idea was set out in Lomonosov's "Short Description of Various Voyages Across the Northern Seas and Evidence of a Possible Passage Across the Siberian Ocean to East India", which he wrote in 1763. He also compiled a general instruction for naval commanding officers setting out in search of a passage to the Orient via the "Siberian Ocean" (Arctic Ocean) for Chichagov's expedition. In 1765 and 1766 this expedition attempted to sail from Spitsbergen to the Pacific Ocean in high Arctic latitudes, where, Lomonosov had suggested, there were passages free of heavy ice. Chichagov, however, failed to get higher than 80° 30' North. The question of whether an ice-free sea existed in the central Arctic was only settled in the 20th century, when it was established that the Arctic polar region was also covered by thick ice. Despite the fact that no solution could be found to this problem in the 18th century Lomonosov's work on the planning of this expedition was an important landmark in the history of the exploration and discovery of a northern sea route.

In terms of content the most comprehensive of Lomonosov's geographical and geological works is his classic *On the Layers of the Earth* of 1763. His ideas on the relations between relief and the geological structure of the earth, his classification of the forms of relief and ideas on the changeability of the earth's surface set out in this work were later successfully developed in physical geography. In his work Lomonosov advanced profound ideas, considerably ahead of their time, on various natural phenomena and objects.

Such, for example, were Lomonosov's ideas on the role of the internal forces of the earth in the formation and change of relief. Specifically he put forward propositions on two types of upheaval and subsidence of the earth's surface—an orogenetic type and slow movements of the land and sea bed.

Lomonosov wrote, for example, about "sinkings of land into the lakes and seas", which as we know now is caused by sea transgressions and corresponding large-scale changes in the dimensions of lakes. He noted: "These actions are almost always associated with earthquakes or with unnoticed, but prolonged rising and falling of the earth's surface."

Lomonosov's ideas on the urgent tasks of exploring the country's natural resources, and particularly the exploration of the North, were very forcefully expressed in *On the Layers of the Earth.* Finally the author outlined the general methodological approach to scientific investigations of the earth's nature which formed the basis of the future sciences of the earth.

Two of Lomonosov's works which were of paramount importance for geography "Discourses on the Origin of Glacial Mountains in the Northern Seas" and the "Short Description of Various Voyages ..." referred to above, are closely connected with the exploration and development of the Far North. In 1760 Lomonosov sent the first of these works to the Swedish Academy of Sciences after he was elected as a member. It was published in 1763 in the "Notes of the Royal Swedish Academy of Sciences". Lomonosov's principal ideas on the origin of ice field are also outlined in the second of these works, which he sent to the Commission on Russian Fleets and the Admiralty. This work was published in 1874. Lomonosov's additions to it can be found in two *Addenda* to this work, written in 1764.

The "Short Description of Various Voyages..." provides a theoretical foundation for the discovery of a northern sea route. Here Lomonosov put forward a number of propositions on the physical geography of the Arctic, which represented a significant contribution to science and received proper acclaim after their further development in the 19th and 20th centuries. We can single out Lomonosov's classification of types of sea ice according to its origin, his ideas on the mutual correspondences in the position and outlines of the continents and oceans, his views on the organic life in the Arctic Basin and on the moderating influence which the Arctic Ocean has on the climate of adjoining land masses.

Lomonosov also wrote important scientific works on the atmosphere, of which special mention should be made of his "A Word on Atmospheric Phenomena Originating from

Electric Force", written in 1753. The ideas on atmospheric electricity and its origin, on the northern lights, the composition of the atmosphere, vertical air currents and the influence of the seas on climate were of great scientific importance. In the field of physical geography Lomonosov's treatment of the problem of ascending and descending air currents is of similar significance. In particular he associated the origin of thunderstorms with vertical ascending currents. At the same time he pointed out that vertical air currents "... are the source and origin not just of electric force thundering in the air, but of many other phenomena inside and outside the atmosphere".

Lomonosov's works in other fields of science were also important for the development of physical geography. These include "A Word on the Birth of Metals from Earthquakes" of 1757 and one of his basic works *The Fundamentals of Metallurgy and Mining* of 1763 to which *On the Layers of the Earth* was an addendum.

The Geographical Questionnaire compiled by Lomonosov paid particular attention to economic geography and was very important for its emergence and development as a science. It was Lomonosov's idea to compile an *Economic Lexicon of Russian* Products, which was to list in alphabetical order the goods produced in Russia. Information on the quantity and quality of products and on their prices was to be gathered in places of production and sale. Two maps were to be appended to this list. Unfortunately Lomonosov died before he completed his work. However the very idea of compiling such a list with commodities holds an important place in Russian geography of the 18th century. It is significant that Lomonosov was the first to use the term "economic geography" in science. This and another term—"economic map" are to be found in a note (circa 1761) containing a list of scientific questions of interest to him.

This short account of the geographical problems which Lomonosov touched on in his works indicates the significance and multiformity of the contribution which he made to geographical science. Lomonosov's scientific ideas on individual branches of geographical science have been analysed in Soviet historical and geographical literature in the context of present-day knowledge, as has the correlation of these ideas with the level of scientific development in Lomonosov's day.

In the final analysis Lomonosov's general methodological views on scientific research, on cognition of the earth's nature had the most profound influence on the development of theoretical thought in the field of geographical knowledge. In this respect one can single out his ideas on the changeability of nature, on causality and scientific forecast contained in his various works. *On the Layers of the Earth,* in which the generalised summary of these ideas is given in the context of geographic issues, was his most significant work for geography in this respect.

The fact that the idea of the changeability of nature was advanced in Lomonosov's *On the Layers of the Earth* as a basic principle of research is extremely important for characterising this work and assessing its role and place in the history of physical geographical thought. It is this very principle which underlies his thesis that the study of the earth's surface and interior "should always rest on solid foundations and rules".

He wrote: "And, firstly, we should remember that the visible corporal things on the earth and the whole world were not in the same state at the beginning of creation as we find them in now. Great changes have occurred in them as is shown by history and by comparing ancient geography with the geography of today, and by the changes in the surface of the earth which occur in our times."

The basic principle on the changeability of the world is inseparably connected with another of Lomonosov's principles—the importance of investigating "causes", on which he wrote:

"And so many believe in vain that everything that we can see was made by the Creator; that not only mountains, valleys and waters, but various kinds of minerals were created together with the world and that therefore there is no necessity to investigate the causes by which they differ in their internal properties and distribution. Such arguments are exceedingly harmful for the growth of all sciences, for the knowledge of the globe's nature and especially for mining, although some conceited men can easily become philosophers by learning the words: 'God created it so' and giving this as a reply to all questions."

Lomonosov came out decisively against teleology and advanced a materialistic understanding of causality in nature in opposition to it. His works contain profound ideas on

the diversity and unity of causal relationships. "Nature is all the more surprising," he wrote, "that it is complex in its simplicity, and that it produces countless kinds of properties, changes and phenomena from but a few causes." At the end of his life in his notes for a work he intended to write on the "entire system of physics" he remarked that "the agreement of all causes is the most constant law of nature", that "causes combine and amalgamate".

On the Layers of the Earth and other of Lomonosov's works mentioned above embody a general approach to the investigation of the earth from a materialistic interpretation of causality. A systematic search for causes and their interrelationships which determine the origin and development of various natural objects and phenomena are characteristic of these works.

Lomonosov believed that scientific investigation of the earth based on "solid foundations", that is on a general interpretation of changes and causal relationships in nature, should serve the purposes of scientific forecast and rational use of the earth's natural resources.

Lomonosov's understanding of the significance of scientific forecast and the practical tasks of science was reflected in the very structure of his *On the Layers of the Earth*, which began with a chapter entitled "On the Earth's Surface" and concluded with "On the Use of the Aforementioned Investigations and Discourses on the Layers of the Earth, Especially in Our Country". This understanding is also clearly expressed in his concluding words: "Nature herself is waiting for our zeal, which may be rewarded by a great retribution."

These propositions on the changeability of nature, on the causal dependencies between natural objects and phenomena and on the relation linking cognition of these dependencies with scientific forecast and the development of natural resources were extremely important for the subsequent advancement of geographical thought.

Geography in the 18th century is often described as having been at the "descriptive stage" of its evolution. But even then the leading scientists were trying to offer geographical interpretations in their investigations of the earth. Eighteenth-century Russian geography produced a number of leading investigators who carried on Lomonosov's train of scientific thought or were associated with it. The views

of the famous explorer S. P. Krasheninnikov, who was a close friend of Lomonosov, took shape as a result of many years of scientific investigation in Siberia and Kamchatka and were basically similar to Lomonosov's ideas on the aims of scientific investigation of nature.

The eminent explorer and scientist I. I. Lepekhin, one of the leaders of the academic expeditions of 1768 to 1774, was strongly influenced by Lomonosov's ideas. The great man's ideas had an undoubted influence on eighteenth-century Russian geography and, as the subsequent development of scientific thought clearly showed, they were considerably ahead of their time.

ACADEMIC EXPEDITIONS OF THE LATE 18th CENTURY AND THEIR CONTRIBUTION TO SCIENCE

Russia remained an agricultural country in the late 18th century, most of the farm land being in its European part. At the same time the number of industrial enterprises continued to grow. The Urals and the areas to the west and east of this range were the major centre for the development of the mining and ferrous metal industries. It was natural that this part of the country should arouse the particular interest of the government, the Academy of Sciences, scientists and developers, as well as that of the Free Economic Society, founded in St. Petersburg in 1765. The most significant of the many geographical activities of this period were the Academy expeditions of 1768 to 1774 which brought Russian science deserved fame throughout the world.

Lomonosov whose leading role in Russian geography is dealt with in the previous chapter died in 1765. His death prevented his "astronomical and geographical expeditions" from being organised. But the extensive programme of geographical work which he presented to the Academy not long before his death and the ideas set forth in it were used in the preparation and organisation of the Academy expeditions.

The Academy of Sciences worked out a detailed set of instructions for the expeditions including requests from individual institutions such as the Colleges of Medicine and

Commerce. One of the expeditions' main tasks was to carry out comprehensive investigations of the nature, population and economy of Russia.

In accordance with this the expeditions prospected for mineral deposits and determined their location and size; they also investigated mineral water springs and medicinal plants. In addition they made surveys of the economy and field management, studied the possibilities of developing agriculture, fisheries and forestry, and determined which fallow lands could be used for agriculture. A great deal of attention was paid to determining the technical and economic level of industrial enterprises. Data was collected which described the actual state of popular education, public health and veterinary science, and gave a picture of the ethnographic features of the population.

The expeditions carried out research in the Kola Peninsula, Byelorussia, the Ukraine, the northern and central areas of European Russia, the Volga region, the Urals, the Caucasus and the coastal areas of the Caspian Sea. Siberia and the Far East received considerably less attention. Nevertheless journeys of thousands of kilometres were made to the lower reaches of the Ob and Yenisei, across the Altai, to some of the more populated parts in the south of Eastern Siberia, to Lake Baikal and further east—to Chita, Nerchinsk and the fort of Argun on the banks of the river Argun. The journey undertaken by P. S. Pallas and his assistant V. F. Zuyev helped to correct many inaccuracies and mistakes which had existed in maps of these particular territories.

As a result of the expedition's work a great deal of material was published containing many verified, well arranged and detailed descriptions. These dealt with the nature and population of millions of square kilometres and provided science with valuable new information. On the basis of this information important scientific conclusions were made and hypotheses advanced on several major problems of physical geography and associated sciences.

The expeditions of 1768-74 were divided into five independent detachments. They were known as the Orenburg and Astrakhan detachments, although their routes went beyond these particular provinces. Their work was directed by eminent Russian scientists or foreigners who had lived for many years in Russia and been employed in the service of the state.

The first Orenburg Detachment was headed by Professor P. S. Pallas*, the second by an adjunct of the Academy of Sciences, Doctor Ivan Lepekhin, the third by Professor Iohann Peter Falk and, after his death, by Doctor of Medicine I. I. Georgi (Iohann Gotlib). Doctor Iohann Gildenshtedt (Güldenstädt), a native of Riga, and Professor Samuel Gotlieb Gmelin were put in charge of the Astrakhan detachments.

Students from the Academy of Sciences were assigned to the detachment leaders to help them with scientific work. Some of them did a part of the research on their own and made a significant contribution to the scientific results of the expeditions. Among these students were Vasily Zuev (Pallas's detachment) and Nikolai Ozeretskovsky (Lepekhin's detachment), who both subsequently became academicians.

As far as the results achieved by these expeditions are concerned, it should be recalled that differentiation between individual sciences both in the field of natural sciences and the humanities only began in the second half of the 18th century. The materials of the expedition contained in the *Daily Notes* kept by the scientists thus include a wide variety of geographical information.

Descriptions of mineral deposits hold a prominent place in the *Notes*. We need only mention Lepekhin's detailed description of combustible shale deposits in the region of the Undory Mountains (Volga Plateau). He also found signs of oil-bearing rocks in those central parts of the Volga region which in Soviet times have become a part of the oil fields known as the "Second Baku". Mineral deposits of local importance were also observed. Lepekhin insisted that their search for minerals should not be confined to regions in the middle latitudes, but extend to the northern territories.

Much of the *Notes* is devoted to detailed descriptions of flora and fauna, particularly in forest regions. Both Lepekhin and Pallas wrote about their grave concern over the ruthless felling of forests which was taking place. They therefore took care to enumerate forest territories, noting the location, area and predominating arboreal species.

All this information taken together gives a sufficiently clear idea of the state of forests in many parts of Russia at that time.

* Peter Simon Pallas was already quite a well-known scientist when he was invited to Russia from Germany. The whole of his subsequent working life was spent in Russia where he became an academician. He returned to Germany just one year before his death.

The *Notes* also contain descriptions of the fauna of 18th-century Russia. They enumerate the different species of animals which inhabited the meadows, lakes and forests on the banks of the Volga and many other rivers at that time (sable, fox, polecat, bear, wolf, ermine, polar fox, otter, desman, beaver); the birds are also described in great detail. A classification of the wild life is given with distinctions being made in size, colouring, etc. N. G. Fradkin has estimated that Lepekhin's *Notes* mention 600 species of plants and over 300 species of animals. Pallas's descriptions of his expeditions of 1768 to 1774 contain 126 pages on zoogeography. In describing hundreds of species of animals he advanced many extremely valuable ideas on their connection with the environment and pointed to the areas of their habitat.

The *Notes* also provide us with extensive and detailed information on hydrography. Lepekhin, for example, made a brilliant description of the Bolshoi Cheremshan River—a tributary of the Volga—indicating the exact position of its source and estuary. It is of great scientific interest to compare this detailed information with our present-day knowledge.

Let us now turn to the theoretical ideas which the authors advanced in their expedition *Notes*, and firstly to Pallas's scientific hypothesis on the origin of the Caspian Sea which was quite amazing for that time. He pointed out that even a long distance from the shores of the Caspian Sea the soil contains sea shells which are still to be found there today. Pallas noted that the shells which were scattered in great numbers throughout the Yaik, Kalmyk and Volga steppes and which were very similar to those in the Caspian Sea were not to be found in the rivers in those parts. Pallas's attention was also drawn to the phenomenon of soil salinity, the striking similarity and in places homogeneity of the Black Sea and Caspian Sea flora, and certain other important signs. "It appears from this that the elevated country between the Volga and the Don along the course of the Sarny River and the elevation known as the Obshchy Syrt lying between the Volga and the Yaik were the ancient coasts of the vast Caspian Sea." Pallas believed that the Caspian Sea was once connected by a narrow strait passing along the valley of today's Manych River with the Black Sea, which at that time had no link with the Mediterranean. Later a strait formed between the Mediterranean and Black Seas as the result of an earth-

quake or some other natural phenomenon. This caused the level of the Black Sea to fall. The Manych Strait dried up and the Caspian Sea was deprived of its inflow. As a result it shrunk considerably in size and became a lake. Large areas of land were thus uncovered. It is possible that the inland Aral Sea formed in the same way. Pallas was thus the first scientist to advance a correct hypothesis about the origin of the Caspian Sea.

The *Daily Notes* contain a great deal of material on the soil cover in various parts of Russia. But the greatest contribution in this respect was made by I. A. Güldenstädt as a result of his journeys through European Russia and the Caucasus. In an attempt to explain the origin of the "black earth which looks like the best artificially enriched garden earth" he put forward the hypothesis that such a large mass of "black matter" had been accumulated by plants whose growth neither man nor animals had impeded. He rightly noted that chernozem is usually found over yellow clay. In his famous work *Russian Chernozem* which was published in St. Petersburg in 1883—almost one hundred years after the appearance of Güldenstädt's works of 1787 and 1791—V. V. Dokuchaev underlined that "as far as we know, the first scientist to propound this particular origin of chernozem was I. Güldenstädt".

The attempts of eighteenth-century scientists to characterise and determine the boundaries of the landscapes which they saw is of great interest to the history of geography. Pallas, for instance, made some very valuable conclusions about the way in which vegetative cover changes as one moves from the chernozem steppes to the solonchak steppe and deserts.

Güldenstädt was probably the first person to give a more or less correct description of the soil, flora and fauna of the steppe zone. He divided the steppes into chernozem and non-chernozem (that is solonchak) varieties. S. G. Gmelin in his turn pointed to an important feature of the steppe zone—very short but heavy showers of rain. In an essay on the Barabinskaya Steppe I. P. Falk noted the way in which it was irrigated "by the branches and brooks" of the Ob. He believed that the Barabinskaya Steppe once had more lakes and marshes than it did in his time.

Of particular interest is Lepekhin's work on the physical-geographical zonation of the Solovyetski Islands, a small group of islands in the White Sea. He divided the territory

of the islands into three parts—southern, eastern and northern—and made a detailed description of the nature in each of them. "The southern region has the best and the most pleasant places which can be found in northern climes. The northern region is twice as big as the southern, whilst the eastern region is very small in comparison to the first two."

The *Notes* also contain a great deal of new information and valuable theoretical statements on questions of orography. Pallas, for example, expressed some important ideas on the general structure of the Ural Range. He noted considerable differences in the position of steep-sloping and gently-sloping rocks and in their composition. On the basis of his own observations and the extensive data gathered by other members of the expedition Pallas attempted to build a general hypothesis on the nature and structure of mountains. He expressed his views in a report to a session of the Academy of Sciences in the summer of 1777—"Observations of the Formation of Mountains and the Changes Which Have Occurred on the Globe, Particularly in Relation to the Russian Empire". Pallas rightly pointed out that the central part of mountains is usually formed from granite. It is abutted or covered by more or less metamorphosed sedimentary rocks. Their shelves are usually deformed and split. The lower outlying foothills are, as a rule, formed from looser rocks.

Güldenstädt concerned himself with the flora and fauna on his journeys across the Caucasus and Transcaucasia. N. A. Gvozdetsky pointed out in his book "History of the Discovery and Exploration of Soviet Asia", that Güldenstädt's ideas on the structure of the Greater Caucasus were on the whole correct. The information which he collected was subsequently used in many of the descriptions and maps of the Caucasus.

Lepekhin's attention was particularly drawn to the origin of karst forms of relief. He visited many caverns in the Urals and the Ural region and gathered a vast amount of data. Lepekhin put forward some important ideas on karst origin. He disputed the widespread view that the caverns were man-made. When he correlated all his observations, the author came to the conclusion that two powerful natural factors played an important part in the process of cavern formation: underground fire and underground waters. He

personally believed that the latter was the more likely cause.

During his journey through the northern part of European Russia Lepekhin became interested in another phenomenon. By making a careful study of the boulders of "siliceous composition" which are to be found in abundance on the banks of the Northern Dvina he came to the conclusion that they could not have been formed there.

Members of the expeditions paid very close attention to studying and describing lakes. Lepekhin made quite a detailed description of Lake Elton—a vast lake with deposited salt. He also described the primitive method of producing salt and the harsh working conditions of the salt cutters. Lepekhin did not believe that the huge concentration of salt in the lake could be explained by evaporation alone. He also noted that in some places the salt formed into blocks consisting of extremely pure and transparent "quadrangular crystals", which were denser than crystals of ordinary lake salt. We now know that Lake Elton is a relict depression lying below sea level and that its salt is to a considerable extent of sedimentary marine origin. Thus Lepekhin's assumption was in general correct.

The expedition, which was disbanded after the death of I. P. Falk, formed into a small detachment under I. I. Georgi, whose main task was to explore Lake Baikal and the surrounding area. In the summer of 1772 Georgi journeyed along the north-west coast of the lake as far as the mouth of the Upper Angara. On the way he became the first scientist to visit the isle of Olkhon (which had been known to the Russians since the 17th century). As a result of his explorations Georgi was able to propound the first scientific hypothesis on the origin of Lake Baikal. He believed that the territory of the lake was a continuation of the Upper Angara Valley. After a violent earthquake the centre of the valley dropped and the lake formed in the depression.

A travelling companion of Georgi, Alexei Pushkarev, carried out a series of hydrographical investigations on the basis of which a special map of the "Baikal Sea" was compiled.

Using actual examples Lepekhin substantiated the correctness of Lomonosov's view on the gradual change of the "face of the earth". He explained, albeit very warily, the appearance of fossils of marine animals found in regions

far distant from the sea in terms of marine transgressions. The *Daily Notes* quote examples confirming the possibility of changes occurring not only in the earth's surface, but in the animals and plants under the influence of the environment. In this way Lepekhin acknowledges the possibility of biological evolution on the planet and attempts to prove it on the basis of actual observations.

Although I. I. Islenyev's expeditions to Yakutsk and the south-west of Russia (1768-73) pursued mostly astronomical aims, he was also requested to gather information on geography and natural history in his travels, and to this end a geodesist Fyodor Cherny was assigned to him. Islenyev's sketches and drawings which were found among his materials served as a basis for the compilation of a map of the Irtysh Basin.

As is clear from the above, the work of the expeditions undertaken between 1768 and 1774 was the most fruitful of the Academy's expeditionary activity in the second half of the 18th century. Among the developments which took place in the last quarter of the century we can mention the travels of the Swede Erik Laksman who came to Russia in 1762 and who made a journey to the north of European Russia (1778-79) on behalf of the Academy of Sciences. The scientist investigated the physical geography, topography and economy of the region, and studied the rocks, ore deposits and mine workings.

Another expedition of short duration, but considerable significance was that undertaken by V. F. Zuev and his three assistants to the south of Russia. It lasted from the spring of 1781 until the beginning of September 1782. Zuev set out the results of the expedition in two publications. The first contained new information on the little-studied gubernias of southern and central Russia. It provided, although somewhat superficially, a geographical zonation of the Novorossiisk gubernia, which Zuev divided into three parts according to the fertility of the land. The second publication described his journey in the Crimea. This was the first description of the nature of the Crimea made by a Russian scientist (not counting Pallas's valuable exploration of the area). Zuev divides the Crimea according to its "very nature" into very distinct parts: a "flat" part, occupying a much greater area, and a smaller "mountainous" part. He describes the differences in their natures and economies.

Of the other journeys made in the late 18th century we should mention the short, but fruitful exploration of Lakes Ladoga and Onega made by N. Y. Ozeretskovsky. The scientist set out to make comprehensive observations of a geographical, historical and economic nature and to make experiments on the "action of oil on troubled waters". He explored several gulfs and islands in Lake Ladoga, several settlements, rivers and lakes (including Lake Onega) and set out the results of the journey which contained much new valuable data in an article entitled "A Description of Lake Ladoga".

In conclusion we should mention two more astronomical expeditions (also in European Russia) besides the Academy expeditions described above. These were the expeditions of P. B. Inokhodtsev (1781-85) and Fyodor Cherny (1785) to the Crimea. Both these expeditions, but particularly Inokhodtsev's, made a considerable contribution to science. Inokhodtsev had the additional task of making certain observations of a general geographic and economic nature. This task was duly performed, individual places being described alongside astronomical data. The Cherny's findings were used to compile a new map of the Crimea.

GEOGRAPHICAL EXPLORATION AND THE DEVELOPMENT OF GEOGRAPHICAL SCIENCE IN THE 19th AND EARLY 20th CENTURIES

This particular period saw a whole host of important events in the history of Russia. There was the Patriotic War of 1812, the wars against Poland, Sweden, Turkey and Persia, the Decembrist uprising against the monarchy in 1825, the abolition of serfdom in 1861 and the steady growth of the working class's revolutionary struggle. And finally the capitalist system in Russia met its end in the first socialist revolution—the Great October Revolution of 1917.

In terms of geographical exploration this period can be divided into two phases: from the start of the 19th century until the 1860s (the pre-reform period) and from the 1860s until the October Socialist Revolution.

Exploration of the territory of Russia and neighbouring regions went hand in hand with the expansion of its borders and the strengthening of trade relations with other states. The Academy of Sciences and many state departments,

particularly the Naval and War Ministries and the Ministry of State Properties, did a great deal of work in studying Russia and the neighbouring territories. A major role in these explorations was played by the Russian Geographical Society. Founded in 1845, the Society was for many years under the leadership of P. P. Semyonov, who later had "Tien-Shansky" suffixed to his name in recognition of his exploration of the Tien Shan Range.

The level of development of geographical science at that time can be judged from the geographical discoveries and explorations, and compilations of geographical maps.

GEOGRAPHY IN RUSSIA IN THE FIRST HALF OF THE 19th CENTURY (CIRCUMNAVIGATIONS OF THE GLOBE BY RUSSIAN NAVIGATORS AND DISCOVERIES IN THE OCEANS)

In the first half of the 19th century a number of circumnavigations and other expeditions to Russian America (Alaska) and Kamchatka were made from Kronstadt. Russian scientists and navigators had plans to circumnavigate the globe in the 18th century and organised in 1787 such an expedition on two vessels under G. I. Mulovsky. The wars with Turkey and Sweden, however, made this expedition impossible. The plans were only implemented between 1803 and 1806 by an expedition led by Captain I. F. Kruzenshtern in the *Nadezhda* and by Y. F. Lisyansky in the *Neva*. The Naval Ministry and the Russian-American Company organised the expedition, whilst the Academy of Sciences directed its scientific work. The instructions for the scientific observations to be made during the voyage were drawn up by Academicians V. M. Severgin and A. F. Sevastyanov, and Rear Admiral G. A. Sarychev. Among the scientists who went on the voyage were naturalists G. I. Landsdorf, I. K. Gorner and V. G. Tilezius von Tilenau.

The first circumnavigation expedition under Kruzenshtern and Lisyansky brought deserved fame to the Russian Navy and Russian geographical science. It discovered and described a number of islands and coastal strips in the Pacific, and extended the knowledge of certain countries and their peoples—the Hawaiian and Marquesas Islands, the north-western part of North America, Kamchatka, Sakhalin, Japan and China. In 1813 Kruzenshtern published an atlas contain-

ing maps of the countries which they had visited, including a map of Japan. In acknowledging the services of Russian scientists the Academy of Sciences pointed out that the voyage had not only increased the standing of the Russian Navy in the eyes of other European countries but as a result of its discoveries and explorations pushed back the frontiers of natural science and geography. Systematic observations of natural history, meteorology and oceanography and their results attracted the attention of scientists abroad, and, in fact, the works of Kruzenshtern and Lisyansky were translated into several foreign languages.

Even before Humboldt Kruzenshtern and Gorner had done much for subsequent developing of meteorology as a science. They subsequently laid the foundations of climatology on the basis of their new method of making systematic observations of atmospheric phenomena in many parts of the globe including islands in the oceans using identical instruments. Observations of ocean currents, their direction, speed, etc., the temperature of sea water at various depths down to 400 metres, the salinity of the water and its luminescence, and tidal movements gave a boost to the development of special oceanographic investigations. Russian scientists discovered the system of currents in the Sea of Japan and the presence of equatorial counter-current in the oceans. Kruzenshtern made an important conclusion about the changing of the boundaries of the equatorial current in the Atlantic Ocean and their dependence on the seasons of the year. By analysing the temperature of the water in the Pacific and Atlantic Oceans at depths of 50, 100 and 200 sazhens* the expedition noted for the first time the features of vertical stratification of the World Ocean. After comparing the observations of water temperature made by Kruzenshtern's expedition with the data in the same points at depths of between 200 and 400 metres in the *Morskoi atlas* (Atlas of the Seas, 1953) the Soviet oceanologist L. F. Rudovits noted that "the measurements made by the first Russian expedition to circumnavigate the globe gave for the first time a clear idea of the nature of temperature distributions in the upper layers of the World Ocean". The expedition established that the salinity of the Atlantic water was greater than that of the Pacific; that the salinity in the upper lay-

* One sazhen equals 2.134 metres.

ers increases as one moves from the tropics to the equator and the higher latitudes; that the salinity of the outlying seas (the Sea of Okhotsk, the Sea of Japan, the South China Sea, etc.) is lower than that of the ocean at large. Scientists put forward some interesting ideas on the heat exchange between the oceans and the atmosphere.

The first circumnavigation of the globe by Russian seamen served as a fine example for other voyages which brought Russian geographical science even greater prestige. In the first half of the 19th century they completed 28 circumnavigations and several voyages half way around the world. No other country in the world at the time could match Russia in the number and thoroughness of these voyages and their scientific results.

Among these expeditions the voyages of the sloops *Diana* (1807-11) and *Kamchatka* (1817-19), under the command of V. M. Golovnin, were of great scientific significance. His expeditions, which were full of drama and adventure, are described in detail in a number of works. Their most important achievements included the gathering of information on Kamchatka and Japan and the peoples inhabiting them, and the compilation of a more accurate map of the Kuril Islands, which was used by navigators for many years after. The voyages of O. Y. Kotsebu, F. F. Bellinsgauzen and F. P. Litke were also extremely valuable for geographical science on the World Ocean. Among the many naturalists who went on these voyages were E. K. Lents, I. I. Eshsholts, E. K. Gofman, I. M. Simonov, P. V. Tarkhanov and A. K. Martens.

Kotsebu's expeditions in the *Ryurik* (1815-18) and the *Predpriyatiye* (1823-26) discovered and described about 400 islands, including a number of large archipelagoes, like the one the natives called Ratak (Marshall Islands), and the coasts of Asia and North America in the region of the Bering Strait, and found a broad gulf in the northern part of Alaska which now bears the name of Kotsebu. Russian names began to appear on the map of the central Pacific Ocean in the Tuamotu Archipelago—Rumyantsev Island (Tikei), Ryurik Atoll (Arutua), Kruzenshtern Island, etc.; and in the Ratak group (Marshall Islands)—the Kutuzov Atoll (Utirik), Suvorov Atoll (Taka), etc. Kotsebu and the scientists travelling with him set out the results of their explorations in reports, in their atlas and in a number of mono-

graphs. Russian scientists (Kotsebu, Eshsholts and others) advanced several interesting hypotheses on the origin of coral islands and the geological unity of the Asian and North American coasts in the region of the Bering Strait (Engelgardt and others). The oceanographical observations which were made on the expeditions according to a pre-planned method using the latest instruments (including Parrote-Lenz's bathometer) were of particular importance. The investigations of Kotsebu, Lenz and others were held in high regard by I. F. Kruzenshtern, S. O. Makarov and Y. M. Shokalsky, and by foreign scientists (Charles Darwin and others) who considered that this work laid the foundations for the science of oceanography.

The expedition of Bellinsgauzen and Lazarev in the sloops *Vostok* and *Mirny* (1819-21) was an event of tremendous significance. They discovered and charted the ice-capped coast of the Antarctic in the region of the present-day Queen Maud Land, Peter I Island, Alexander I Land and other Antarctic islands. The expedition laid the foundations for the study of the sixth continent and the physical-geographical phenomena associated with it. The members of the expedition described for the first time the nature of the Antarctic coast and adjacent parts of the ocean, and the formation of floating icebergs.

Bellinsgauzen came to the conclusion that the heavy ice which barred the sloops' way to the South Pole (he called it "continental") was a continuous and immovable ice body that covered the pole. He wrote that it rested on shallow water or on islands like Peter I Island or Alexander I Land. This hypothesis was accepted until quite recently by a number of scientists. It was only as a result of investigations carried out in the Second International Geophysical Year and subsequent years that this opinion was put in doubt. Nevertheless the possibility that an ice-covered land exists below sea level in the Antarctic cannot be discounted.

At the same time as Bellinsgauzen was exploring the Antarctic, the expedition of M. N. Vasilyev and G. S. Shishmarev to the Arctic Ocean was trying to find a passage from the Pacific to the Atlantic and ascertain the contour of the northern coastlines of Asia and North America. At that time no clear idea existed of the northern coasts of North America and many people thought this continent occupied a large part of the Arctic Ocean and was linked by a narrow neck

of land with Asia in the area of Wrangel Island or the Novosibirsk Islands. Vasilyev, who sailed further to the east along the North American coast than any other navigator of the day, successfully continued the work of Kotsebu and other Russian scientists. He made a careful study of the ice conditions of the coast and coastal currents, and discovered the surface transfer of water and ice from the Arctic Ocean to the Pacific Ocean.

F. P. Litke's navigations and research in the Arctic Ocean (1821-25), and his circumnavigation in the sloop *Senyavin* (1826-29) yielded important results in the field of geography and oceanography, and on the theory of geomagnetism and the elucidation of the shape of the earth. Litke explored and described the coast of Asia from Petropavlovsk-Kamchatski. to the Bering Strait, the Caroline Islands and other regions. He discovered a group of coral islands which were named Senyavin Islands. His hydrographical surveys and astronomical and geodesic measurements served as a basis for the compilation of over 50 maps, which were included in the *Morskoi Atlas* (Atlas of the Seas) of 1835. His observations in the field of ethnography, zoology and botany were also of great interest. M. N. Stankevich described the American coast from Alaska to the Bering Strait (1826-29) at the same time as Litke. The results of his explorations were widely used for compiling summarising maps and atlases.

The regional maps and atlases compiled by Russian scientists and navigators such as Kruzenshtern's *Atlas of the Southern Sea* (Part I published in 1824, Part II in 1826); G. A. Sarychev's *Atlas of the Northern Part of the Eastern Ocean* (1826) and the later works of A. F. Koshevarov (1850) and M. D. Tebenkov (1852) contained the latest information on the coasts of seas and oceans, on the geographical position of individual islands and archipelagoes and their links with the continents. They rivalled the best foreign maps in their accuracy and were widely used by navigators for many years after their publication.

The geographical materials obtained as a result of the circumnavigation expeditions made by Kruzenshtern, Lisyansky, Golovnin, Kotsebu, Litke and others played an important role in understanding the physical-geographical conditions on the earth and studying population. They had a considerable influence on world geographical science, as they were translated into foreign languages immediately after

publication. These works are still of considerable significance today, since they allow us to ascertain the changes which have occurred in the natural environment over the years. The descriptions made by Russian navigators and scientists were quite detailed and extremely accurate.

The inland seas and coastal waters of Russia were also investigated by special hydrographical expeditions. This was dictated both by the development of fisheries and seal hunting in these seas (in the Arctic Ocean, the Caspian Sea, etc.) and by the need to consolidate for Russia the newly-discovered lands and develop merchant shipping. A large number of vessels took part in the expeditions which commissioned hydrographers and topographers to compile accurate charts of the seas and describe their physical geography. The seas linking Russia with Europe—the Baltic, the White and the Black seas—were the subject of an intensive study.

The major explorations made during this period resulted in the appearance of several fundamental cartographic works. These include: the first naval atlases describing voyages from the White Sea to the Baltic Sea, and an atlas of the White Sea; the atlas of L. I. Golenishchev-Kutuzov (1800; 1862); G. A. Sarychev's atlas of the Baltic Sea (1812); atlases of the Black Sea by I. M. Budishchev (1807) and Y. P. Manganari (1841); M. F. Reineke's atlas of the White Sea (1833). Manganari's atlas makes wide use of a method which shows the depths of the sea by means of isobaths. Sailing directions and descriptions of coastlines, which were usually compiled together with the charts, served as an aid to understanding the physical-geographical features of the seas and their coasts. These include: Sarychev's chart of the Baltic Sea (1817), Budishchev's (1808) and Manganari's (1841) charts of the Black Sea, and the fundamental summaries of Kruzenshtern (1823, 1826) and Reineke (1843, 1850).

With the application of triangulation and the recording of chronometric observations (the work of V. Y. Struve and F. F. Shubert) accurate charts were produced. Charts compiled from these observations (the chart of the whole of the Baltic Sea, for example) were the best charts in the world in terms of accuracy and detail.

In 1826 A. Y. Kolodkin produced an atlas of the Caspian Sea. Subsequently a more detailed configuration of some areas of the sea was elaborated (in particular I. I. Zherebtsov discovered and described the Gulf of Kara Bogaz Gol;

N. A. Ivashintsov's expedition made a detailed survey of the Caspian Sea, whilst an expedition under I. A. Butakov completed the same task in the Aral Sea.

Scientific interest in the explorations of coastline and islands in the north of Siberia was linked with the discovery by Russians of a number of islands in the New Siberian Islands (Fadeev Island in 1805, Novaya Sibir in 1806, the Vasilyevsky and Semenov Islands in 1815), and the search for the problematic "Sannikov Land" and "Andreev Land". As a result of the work of three expeditions—M. M. Gedenshtrom's expedition to the New Siberian Islands (1808-12), P. F. Anzhu's Yana Expedition (1820-24) and F. P. Wrangel's Kolyma Expedition (1821-24)—the Siberian coastline and numerous off-shore islands were surveyed from the Lena almost as far as the Bering Strait. Anzhu and Wrangel compiled more than 26 maps and plans based on 115 astronomical measurements of reference points. Observations of the severe nature of these regions were collated in scientific reports and works; the boundary of the Siberian shore ice belt was established and observations made of permafrost, regimes of rivers, etc.

G. I. Davydov, N. A. Khvostov, A. Y. Shakhovsky and V. K. Poklonsky did a great deal of work on the seas of the Far East while sailing in vessels of the Russian-American Company. In 1843 A. F. Middendorf made a detailed survey of the southern coast of the Sea of Okhotsk and the Shantar Islands. In the middle of the 19th century a very intensive study was made of the southern coast of the Sea of Okhotsk, the Amur Estuary and the Sea of Japan. The lands of Sakhalin and the Amur and Ussuri basins were rapidly opened up and populated. The expedition led by the Russian navigator G. I. Nevelskoi (1849-55) proved that Sakhalin was an island and that the estuary of the Amur was accessible for navigation from the north and south. Nevelskoi paved the way for the development of the lands in the Russian Far East. In 1850 he founded Nikolayevsk-on-Amur, the Russian posts in the Gulf of Chikhachev (De-Kastri), Sovetskaya Gavan (Khadzhi) and in several parts of Sakhalin. Several accurate maps of Primorye and North and South Sakhalin with descriptions of their nature and population and the conditions in the surrounding waters were compiled as a result of Nevelskoi's explorations. He described the heroic saga of this expedition in his *Feats of*

Russian Naval Officers in the Far East of Russia, which was published after his death.

As a result of Nevelskoi's expeditions the way was opened for various kinds of explorations of the Russian Far East. In their wake other parties of Russian scientists set off along the rivers Amur and Ussuri, into the Sikhote Alin Range, to the coast of Primorye and Sakhalin to investigate the nature and population of these regions, which had been associated with Russia for many centuries. As a result of the extensive hydrographical and cartographical work carried out in the area new names of gulfs, islands and capes appeared on the map for the first time. In 1859 a naval reconnaissance expedition under N. N. Muravyev-Amursky discovered and surveyed the Bay of Nakhodka, and a number of other bays and gulfs, including the Gulf of Peter the Great. Here, in the bay of Zolotoi Rog, the town of Vladivostok was founded (1860).

In the 1860s V. M. Babkov, K. S. Staritsky and L. P. Yelagin began a systematic survey of the Russian coastline. As a result charts were compiled of the coast of the Sea of Japan and astronomical and geodesic work done on referencing the most important points in this sea and the Okhotsk and Bering seas. Attempts were made to collate the available data on the physical-geographical conditions of these regions. We may include in this category a guide for navigation in the Gulf of Tartary and the Amur Estuary which gives a brief, but sufficiently clear geographical description of the coasts of Sakhalin and Primorye.

GEOGRAPHICAL STUDY OF RUSSIAN TERRITORY

Russia, the world's largest continental power, always attached great importance to the study of its own territory and neighbouring lands. The first half of the 19th century saw widespread astrogeodesic and cartographical activity in European Russia, Central Asia and the Caucasus to determine geographical coordinates, measure the distances along meridians and parallels, and compile maps. Among the scientists who made a major contribution to these studies were D. I. Shubert, V. K. Vishnevsky, F. F. Shubert, K. I. Tenner, V. Y. Struve, I. I. Khodzko and I. I. Stebnitsky. The cartography of European Russia was given an accurate basis and

coordinated with the cartography of Western Europe. This work was very important both for establishing the relative position of particular geographical objects and for solving the problem of the shape and exact dimensions of the earth. In assessing the results of the cartographical and geodesic work undertaken by the School of Military Topographers, which F. F. Shubert collated in 1858, foreign journals pointed out that at least in the field of geography Russia had overtaken other European states and made unexpected and truly amazing progress. Shubert's work was considered one of the most important for geography at that time.

In the first half of the 19th century there appeared major summary cartographical works covering vast territories of Russia which put the country into a leading place in the field of cartography. One can single out A. M. Vilbrekht's *Detailed Map of the Russian Empire* (1789-1818) and the *Special Map of Western Russia* (1821-38). Maps on the Caucasus included the general maps of Verkhovsky (1817), A. I. Khatov (1819) and Khoven (1834, 1838), which served as a basis for the compilation and publication of subsequent, more accurate maps of the Caucasus (1842, 1847 and 1850). The most significant of the maps of Siberia and Central Asia were those of Southern Siberia and the neighbouring countries by K. I. Tenner and A. I. Maksimovich (1806-07), F. I. Pozdnyakov's map of Asiatic Russia (1825), A. K. Timofeev's *Map of the Kirghiz-Kaisak Steppe and Turkestan* (1831), and Babikov's *Map of the Territory of the Central Kirghiz-Kaisak Horde and Neighbouring Hordes and Territories* (1833). The maps drawn up by S. V. Krutikov (1854), A. F. Middendorf and V. V. Vaganov (1859), and those made by members of the expeditions of G. I. Nevelskoi and L. E. Shvarts (1867) laid the foundation for the modern orographical map of the southern part of Siberia, the Amur region, Primorye and Sakhalin. Among the cartographical works describing the territory of foreign countries we should mention N. G. Rubtsov's map of South America (1822-27), M. P. Vronchenko and P. A. Chikhachev's map of Asia Minor and L. A. Zagoskin's map of Alaska.

In the course of the geographical explorations of this period a clearer idea was gained of individual regions of Russia, its orography, hydrography, population and economy. The most significant explorations of the central, western and southern parts of European Russia was done by

N. Y. Ozeretskovsky, V. M. Severgin, K. I. Arsenyev, I. A. Dvigubsky, K. F. Rulye, P. I. Keppen and K. M. Ber; in the northern part and the Urals the principal explorers were A. I. Shrenk, F. I. Ruprekht, P. I. Kruzenshtern and A. A. Keizerling (on R. Murchison's expedition), G. E. Shchurovsky and E. K. Gofman.

As a result of these explorations more accurate maps were produced of these regions and a detailed study made of their nature. The investigators discovered the Pai-Khoi Range, the Timansk Ridge and the Polar Urals, made a more accurate study of the orography and hydrography of the tundra in Bolshaya Zemlya, compiled geographical descriptions and explored the nature of the Kola Peninsula, the Pechora Hollow, almost the whole of the Urals, the Caspian lowlands and other regions. The results of these investigations were published in the form of reports and general geographical descriptions of territories, giving information both on physical geography and economics.

The works of the eminent historian and geographer K. I. Arsenyev, which contain a description of European Russia, were significant in this respect. Arsenyev considered European Russia as a "vast plain" in which he distinguished a number of orographic regions; these included: the central elevated region (with the Valdai Hills), the Volyno-Podolsk region and the Volga region. In the economic field he distinguished several "spaces" or "integrations of three types of regions—large, medium and small". The work of Arsenyev, like that of Keppen, and many other explorers included a description of both natural conditions and the economic activity of the population. They most clearly reflected the state of geographical science at that time when no distinction was made between physical and economic geography. The teaching of geography and statistics in the universities, which from 1804 onwards was conducted in the departments of geography and statistics of Russia and foreign countries, was of a similar nature.

More specialised branches of geographical science began to feature more and more prominently in the works of Russian naturalists and explorers. Severgin, for example, specialised in the study of relief; Ozeretskovsky and Dvigubsky—in plant and animal life, rivers and lakes; Ruprekht—in vegetation and soil; and Ber—in relief and the animal world.

Severgin developed the idea that river valleys originated

from lacustrine erosion and the idea of the levelling of relief with time and the formation of plains. In his *Experiment in Mineralogical Surveying* (1809), which was the first correlation on the geography of minerals in Russia, he gave a detailed description of the country's rivers and relief. The author made a general orographic sketch of the territory, distinguishing its principal features (mountains, plains, lowlands), and described areas of water catchment in sea and river basins. He was one of the Russian researchers who developed the evolutionary ideas which Lomonosov introduced into geography and geology in the 18th century.

Another supporter and proponent of Lomonosov's ideas on the evolution of the earth's surface, and the origin and genesis of relief was I. A. Dvigubsky. His works on the flora and fauna of the Moscow gubernia were the first of their kind to be published in Russian. The works of K. F. Rulye, who examined the interrelationships between natural phenomena, were of great theoretical and methodological significance for physical geography.

A. I. Shrenk, who studied the flora of the tundra, did a great deal to specify the features of relief of the Polar Urals and the neighbouring areas. He noted the presence of mountains on the Yugor Peninsula and indicated that the island of Novaya Zemlya is a continuation of the Urals through the Pai-Khoi Hills and Vaigach Island. Shrenk described how tundra plants adapt to their environment.

A. A. Keizerling and P. I. Kruzenshtern did much to interpret the orographical and geological structure of the Pechora Basin and the Urals. The works of G. I. Shurovsky, E. K. Gofman, A. I. Antipov and N. G. Meglitsky, who all studied the Urals, were of a similar nature. They developed an orographic outline of the Southern Urals and made an attempt to explain the differences in the forms of relief by geological structure.

F. I. Ruprekht, who studied the tundra and forest zone of European Russia and the neighbouring regions of the Urals and Siberia, distinguished several areas there: the forest belt of Western Siberia, the plain of the Vishera River, the Bolshaya Zemlya tundra, the Arctic regions to the north and north-east of the Urals and the Ural Ridge. He refuted the accepted view since Pallas that the Urals serve as a boundary between European and Siberian types of forest vegetation. The forest belt in Western Siberia, he

wrote, does not differ from the Vishera region, but is vastly different to the Ural Ridge itself, which is characterised by many alpine plants in the same latitudes. I. F. Brandt studied the geographical distribution of animals in the northern part of European Russia from Lappland to the Urals.

The study of fisheries on the Volga and the Caspian Sea carried out under K. M. Ber between 1853 and 1857 made it possible to advance a number of important geographical hypotheses. Among the most interesting of these were Ber's views on the formation of the Caspian Sea basin and the sandhills (Ber's hills) of the Caspian lowland, and the "general law on the formation of river beds" (Ber's law). Ber linked the formation of the Caspian Sea and the fluctuation of its water level with tectonic processes and did not accept that it was gradually drying up. He explained the specific features of the Caspian lowland relief by water action of an ancient sea. Finally, according to Ber's law, the right bank of rivers flowing in a north-south direction in the northern hemisphere is always elevated, and the left bank is flat.

Like P. A. Slovtsov, who first noticed it in Siberia in 1837, Ber associated this phenomenon with the rotation of the earth about its axis. The first half of the 19th century also saw a number of expeditions to the Asian part of Russia and neighbouring territories. The most important expeditions in Siberia and the Far East were those of Middendorf to the Taimyr Peninsula, Yakutia and the Amur region (1842-45), and the Transbaikal expedition of L. E. Shvarts and F. B. Shmidt (1855-62). In Turkestan the expeditions of F. I. German (1815) and I. P. Shangin (1816) discovered and explored the area of low, rounded, isolated hills in Kazakhstan; N. N. Muravyev (1819-21) and G. S. Karelin (1839) studied the nature of the Transcaspia and compiled a more accurate map of it; A. Negri, E. A. Eversmann and others (1820-21), K. F. Butenev (1841-42) and G. I. Danilevsky (1842) investigated the nature of the Aral region, and the Bukhara and Khiva Khanates; A. I. Shrenk, A. G. Vlangali and T. F. Nifantyev explored Semirechye, and A. I. Butakov studied the Aral Sea (1847-48). Russian scientists penetrated into the mountainous regions of Tien Shan. Both natural scientists (Y. I. Parrot, E. I. Eikhvald, A. Y. Kupfer, G. V. Abikh and others) and military geographers and geodesists made intensive surveys of the Cau-

casus. After the annexation of Transcaucasia to Russia military geographers and geodesists penetrated the wildest and most distant regions of the Caucasus, compiled maps and made descriptions of its various provinces (Solomatin, Churkin, Fedorov, Vasilyev, Petrov and others).

Studies of the country undertaken by local administrative and economic institutions played a major role in all parts of Russia. Government decrees imposed upon them the duty of compiling geographical and statistical descriptions of the gubernias. A. I. Losev, P. A. Slovtsov, I. I. Güldenstät, S. S. Shchukin and N. S. Shchukin, who took an active part in the study of Siberia, put a great deal of work into these descriptions. Losev's geographical and statistical description of the Irkutsk gubernia like the works of K. I. Arsenyev provide a vivid and detailed picture of Siberia and its regional differences. P. A. Chikhachev and G. E. Shchurovsky published works on the Altai. Mention should also be made of the works of I. V. Rovinsky (1809), S. Bronevsky (1823) and I. F. Blaramberg (1834, 1835) on the Caucasus, and those of A. Levshin (1832), N. V. Khanykov (1843) and I. F. Blaramberg (1848) on Kazakhstan and Central Asia.

It was in the course of such geographical investigations and the study of the country's territory, the individual components of its nature, population and economy that Russian geographical science developed. G. V. Abikh, who worked for many years in the Caucasus, elaborated in his works a detailed orographic outline of this mountainous country, studied its geological history and described specific geomorphological regions, in particular the Armenian volcanic upland. Abikh determined the limits of the snow cover and wooded regions in the Caucasus. E. A. Eversmann made important discoveries concerning the nature of the steppes and deserts of Turkestan. He distinguished various natural zones and landscapes in the Orenburg gubernia. T. F. Nifantyev, who studied the Tien Shan Mountains, added to the knowledge of their orography and hydrography and described for the first time the alpine plateaux (*syrts*).

In the course of his diverse explorations in the north and east of Siberia A. F. Middendorf described the peculiar nature of the region. His scientific ideas were developed in the works of R. K. Maak, who studied the Vilyui and Amur regions, and those of K. I. Maksimovich and G. I. Radde, who investigated the Amur region and Primorye. N. G. Meg-

litsky, who studied the geology of Eastern Siberia, directed his attention towards the origin of Lake Baikal.

Mention should be made of the explorations of vast areas of Central and Eastern Asia carried out by Y. F. Timkovsky (1820-21) and N. Y. Bichurin (1807-22). Asia Minor was investigated in detail by M. P. Vronchenko (1834-36) and P. A. Chikhachev. The latter made eight expeditions and wrote a monumental work on the nature and economy of this region. Y. P. Kovalevsky and L. S. Tsenkovsky were among the Russian geographers who made explorations in Africa, whilst G. I. Langsdorf headed an expedition to South America (1821-29).

DEVELOPMENT OF RUSSIAN GEOGRAPHY IN THE LATE NINETEENTH AND EARLY TWENTIETH CENTURIES

A feature of late nineteenth-century Russian geography was the contribution which Russian explorers made to the exploration of Central Asia. This particular period may be regarded as the era of Russian geographical discoveries in this part of the Eurasian continent. The expeditions of N. M. Przhevalsky, M. V. Pevtsov, G. N. Potanin, G. Y. Grum-Grzhimailo, B. L. Grombchevsky and V. A. Obruchev are well known in the history of world geographical science. As a result of their explorations vast new regions and mountain ranges were discovered, and the orography, hydrography and other natural features of these territories studied. All this provided cartographers with new accurate data concerning geographical coordinates.

An even more characteristic feature of this period was the comprehensive study of the principal agricultural areas in European Russia, Western Siberia and the cotton-growing areas of Central Asia. Minerals were sought in little-known parts of the country. The study of virgin lands in Siberia, the Far East, Kazakhstan and Central Asia with a view to possible development acquired particular importance.

A process of differentiation of geographical science started on the basis of these explorations, since every component of nature underwent more profound and comprehensive study. Specialisation in geographical research became increasingly noticeable. At the same time the general

development of natural sciences promoted their integration on the basis of the very nature of the earth's surface, its uniqueness and the interdependence of all phenomena and processes which occur on it. From the 1860s favourable conditions took shape for the development of the general scientific ideas of Lomonosov, Humboldt and other leading natural scientists on interrelationship of natural processes. Darwin's doctrine on evolution and Lyell's conception of actualism also had a considerable influence on the development of physical geography. In addition the world outlook of Russian scientists was to a great extent based on the advanced materialistic philosophy of the revolutionary democrats.

In the subsequent study of the nature of European Russia, the Urals, the Caucasus, Central Asia and Siberia, and in the investigations of man's economic activity great importance was attached to the combined efforts of various expeditions organised in the latter half of the 19th century. Research undertaken by expeditions in European Russia yielded the best results. These included: I. I. Zhilinsky's investigations (1873-98) on the drainage of marshland and the irrigation of the arid lands in the south; A. A. Tillo's explorations (1894-99) of the upper reaches of the main rivers of European Russia; V. V. Dokuchaev's multiple study (1870-1890s) of all aspects of natural conditions in their entirety; other investigations such as those on the grain trade, the efficiency of agriculture, etc.

Progress in cartography and geodesy created a firm basis for all these investigations by ensuring complete and accurate geographical descriptions. Among the notable cartographical works of this period were *Special Map of European Russia* compiled under I. A. Strelbitsky (1865-71); a map of the Caucasus compiled in Tiflis (Tbilisi) under I. I. Stebnitsky; a map of Asian Russia made under A. A. Bolshev (1884, 1888) and E. A. Kaversky (1895); aggregate maps of Western Siberia and Turkestan. Towards the end of this period Marx's *Large Table Atlas of the World* (1905, 1909), and the *Atlas of Asian Russia* (1914) appeared in Russia.

The early 1860s witnessed the first attempt to depict the relief of some areas of European Russia and the Caucasus using colour layering. This method was later successfully employed in the compilation of *Relief Map of the Caucasus* (1869), *Map of the Heights of Inner Asia* (1872) and *Orographic Map of Asian Turkey* (1882); it became universally

accepted after the compilation in 1889 of A. A. Tillo's widely-known *Altimetric Map of European Russia.* According to D. M. Anuchin the latter map marked a new era in the development of Russian orography and hypsometry. In 1896 Tillo drew up an altimetric map of the western regions of European Russia and neighbouring countries.

Considerable progress was made in the study of the relief and geological structure of Russia. This was due in large part to investigations on the Russian Plain and in the Urals (N. A. Golovkinsky, I. F. Levakovsky, V. V. Dokuchaev, S. N. Nikitin, A. P. Pavlov, A. P. Karpinsky and others), in Siberia (P. P. Kropotkin, I. D. Chersky, V. A. Obruchev and others), Central Asia (P. P. Semenov, N. A. Severtsov, A. F. Middendorf, I. V. Mushketov, V. A. Obruchev and others) and the Caucasus (G. V. Abikh, I. I. Stebnitsky, K. I. Podozersky and others). Russian scientists not only threw light on geological structure and its relationship with the orographic elements of the earth's surface on these territories, but resolved important theoretical tasks.

A great deal of attention was given to the processes by which river valleys are formed and to the origin of erosion relief as a whole in the works of N. A. Golovkinsky (1865, 1868), I. F. Levakovsky (1869, 1870), V. V. Dokuchaev (1878) and I. D. Chersky (1878); and to the theory of continental glaciation in the works of P. A. Kropotkin (1875, 1876), A. A. Shtukenberg (1875, 1878), I. D. Chersky (1881), G. N. Nikitin (1883), A. P. Pavlov, D. N. Anuchin and others.

In the mid-1860s N. A. Golovkinsky advanced a hypothesis on continental glaciation of the earth, which was developed into a well-founded theory by P. A. Kropotkin after many years of research in Eastern Siberia and, particularly, in the north-west of European Russia. Kropotkin's *Research on the Ice Age* of 1876 marked an important stage in the development of physical geography.

V. V. Dokuchaev made a detailed study of river valleys in European Russia and linked their formation with the ice age and post-glacial lake formations. His work aroused a good deal of interest among Russian scientists, but remained unknown abroad.

I. D. Chersky developed a theory of stage formation of relief according to which highly elevated terrain can in the course of geological time erode into plains. In the opinion

of Soviet scientists this theory in many ways anticipated the well-known ideas of the American scientist Davis on "geographical cycles" of relief development.

The study of Central Asia drew attention to desert forms of relief: the formation of sand-hills, the development of sand relief and the part played by vegetation in this development.

A. P. Karpinsky and V. A. Obruchev distinguished various forms of tectonic phenomena and underlined their role in the formation of relief.

Investigations on the hydrography and hydrology of the land carried out by geographical expeditions are also closely connected with the study of relief. These investigations embraced almost all the country's navigable rivers and lakes. The most important of the major expeditions of this kind were those to lakes Ladoga and Onega, the lakes of the central regions of Russia and Central Asia, and Lake Baikal.

D. N. Anuchin's research on the lakes of the Upper Volga region (1894-95) and his methods stimulated study of lakes in many areas of Russia which laid the foundations for limnology based on a geographical approach. L. S. Berg's monography *The Aral Sea* (1908), which gives a comprehensive geographical description not just of the Aral basin itself, but of the surrounding territory and touches on the paleogeography of the whole of Central Asia, is a classic example of the study of lakes in Russian limnology.

Stationary investigations of rivers and lakes using water gauges and stations were first undertaken in 1880. A whole series of works appeared on the major rivers: V. M. Lokhtin wrote about the rivers Chusovaya and Dniester (1878, 1886); N. A. Bogoslovsky concerned himself with the Volga (1887); N. I. Maksimov described the Dnieper (1901); and M. N. Gersevanov studied the rivers of the Caucasus (1886). V. M. Lokhtin, N. S. Lelyavsky and V. G. Glushkov laid the scientific foundations for the study of fluviomorphological processes in rivers and river discharge.

Russian scientists studied rivers and lakes in conjunction with climatic features and geological conditions. The ideas of the leading Russian climatologist and geographer A. I. Voyeikov on the interrelation between river and lake regimes and the climate were extremely fruitful. He viewed rivers and lakes as a "product of climate". In developing

this concept the scientist put forward an original climatological classification of rivers. Voyeikov's main service, however, lay in the fact that he was the first man to carry out climatological research which gave a profound analysis of the essence of atmospheric phenomena in general. His *Climates of the Globe, Especially in Russia* of 1884 had a great influence on the development of science as a whole and laid the foundations for modern climatology. This work is based on a study of atmospheric circulation, the solar radiation balance and the underlying surface of the atmosphere and their interrelation.

The study and generalisation of observations of atmospheric phenomena made by the Main Geophysical Observatory under G. I. Vild were of great significance for the development of climatology in Russia. These investigations led to a whole range of valuable scientific works including a major cartographical work, *Climatic Atlas of the Russian Empire* (1900), which was edited by M. A. Rykachev.

In the latter half of the 19th century the basis of a new science—genetical pedology—was developed in Russia, which regarded the soil as a specific body of natural history emerging from the interaction of several factors of soil formation: climate, bed-rock, vegetation and animal organisms, the age and relief of the country. The founder of this new science was V. V. Dokuchaev. His concept of soil and general scientific views revolutionised natural science. V. I. Vernadsky, the founder of modern geochemistry and biogeochemistry, observed that "in the history of nineteenth-century Russian natural science few people have exerted such influence on the course of scientific work, or rivalled the profoundness and originality of his generalisations". By developing his concept of soils and their geographical distribution and taking a multiple approach to the study of natural phenomena Dokuchaev created the doctrine of the integrity and indissolubility of the geographical environment and discovered a basic geographical law—the law of geographical zonation. After throwing light on the zonation of nature in European Russia he extended this concept to the world as a whole. Dokuchaev distinguished five main physico-geographical zones: the boreal (tundra) zone, the forest or taiga zone, the chernozem zone, the zone of arid subtropical regions and the laterite, or red-earth zone of tropical countries.

Dokuchaev linked progress in physical geography with genetical pedology and considered the latter as one of its most important principles. In 1895 he wrote that "for *physical geography* and, particularly, for the study of Russia, the science of soils serves as one of the most important principles". At the turn of the century Dokuchaev determined the content and tasks of the new science. He wrote: "Recently one of the most interesting *disciplines* in the field of modern natural science has taken shape and increasingly gained independent existence. I refer to the study of those multiform and diverse correlations and interrelations, and equally to the *laws* governing their changes over the centuries, which exist between so-called animate and *inanimate nature*, between a) surface rocks, b) the plasticity of the earth, c) soils, d) surface and ground waters, e) the country's climate, f) plant and g) animal organisms (including and, even principally, lower organisms), and h) man, the majestic pinnacle of creation." He believed that this science should be at the very centre of all the most important disciplines of modern natural science and that the methods used in soil science should form the basis of its methods. Dokuchaev's development of the new science was consonant with the determination of the content and tasks of physical geography outlined by A. Humboldt, who considered that the study of the correlations and interrelations between animate and inanimate nature was the main task of physical geography. The creator of genetical pedology, Dokuchaev was at the same time one of the founders of Russian physical geography.

The methods of field geographical and soil research elaborated by Dokuchaev and his pupils were widely used and developed in the study of various regions of the country, such as the Caucasus, Siberia, Central Asia and the Far East. S. A. Zakharov's expeditions, for example, provided the first materials on the soils of the Caucasus. The influence of Dokuchaev's ideas was most strongly felt in the works of those scientists who took part in the Migration Department's expeditions led by S. S. Neustruev and K. D. Glinka. The materials gathered by these expeditions contain descriptions of the whole natural complex of the vast territory of Asian Russia (Siberia, Kazakhstan and Central Asia). Among these materials was an individual map depicting the first physico-geographical zonation of this territory made by L. S. Berg.

The study of the flora and fauna of Russia was closely associated with soil research. Increasingly, plants and animals came to be regarded as a component part of nature, closely linked with the conditions of their habitation. From this point of view great interest attached to P. P. Semenov's investigations into vegetation and N. A. Severtsov's research on the life of animals in the central regions of European Russia. The researchers attempted to establish on the basis of actual results the dependence of plants and animals on the conditions of their habitation (environment). This field was later developed in Russia in the works of A. N. Krasnov, G. I. Tanfilyev and many others who studied the nature of vast expanses of the country from the western borders of Russia to Kamchatka and the Far East.

The Russian traveller, botanist and geographer A. N. Krasnov was profoundly interested in the interrelation between soil and vegetation. He worked on the acclimatisation of the tea shrub in Transcaucasia. In his *Grasslands of the Northern Hemisphere* (1894) and *The Geography of Plants* (1899) he set out the principal regularities in the distribution of vegetation over the earth's surface, particularly in arid zones. A geobotanist, soil scientist and physical geographer, G. I. Tanfilyev devoted a great deal of his time to the study of tundra, forest and steppe zones. He collated materials on the vegetation of Russia and put foward one of the first plans of the geobotanical zonation of the country as a whole.

On the basis of the ecological and geographical approach there emerged and developed in Russian science the concept of plant formations and communities (I. K. Pachosky, G. F. Morozov). An ardent supporter of Dokuchaev, Morozov developed the concept of the forest as a vegetative community. His ideas were later developed by V. N. Sukachev, B. A. Keller, V. V. Alekhin and others. Regional research (N. I. Kuznetsov, P. K. Krylov, I. M. Krasheninnikov) represented a major contribution to the development of geobotany.

Besides N. A. Severtsov the ecological and geographical trend in zoogeography was developed by A. F. Middendorf, M. N. Bogdanov and M. A. Menzbir.

Thus by studying the mutual relationships between individual animate components of nature and their environment Russian botanists and zoologists made a considerable

contribution to the development of physical geography. The works of A. N. Krasnov, G. I. Tanfilyev, G. F. Morozov and L. S. Berg, which concentrated on the general study of the country's nature, were of particular value in this respect.

It is clear from what has been said that as a result of many years of expeditionary investigations in various parts of Russia, in natural conditions ranging from the severe cold of the Arctic regions to the subtropical heat of the Black Sea coast and Central Asia, Russian scientists successfully laid the foundations for such geographical disciplines as cartography, geomorphology, climatology, hydrology of the land and biogeography. The achievements of Russian geography were thus built on a broad basis of investigations carried out by soil scientists, botanists, geologists and other specialists. These important scientific ideas are clearly expressed in the works of the pupils and followers of Dokuchaev (G. N. Vysotsky, A. N. Krasnov, G. I. Tanfilyev, S. S. Neustruev, L. S. Berg, G. F. Morozov).

At the start of this century these scientists developed the theoretical principles of physico-geographical zonation and landscape science. In 1913 G. F. Morozov advanced the geographical concept of "landscape" as an objectively existing unit of natural history.

Investigation of zonal and other natural features of the earth's surface led Russian scientists to distinguish a special envelope of the earth, with which the science of physical geography is concerned. This concept was first developed by Russian scientists in the 19th century following the work of E. K. Lents, who introduced a biological component into the science of physical geography and regarded the earth's surface as a sphere of interaction between the solid surface, the atmosphere, the hydrosphere and living organisms. This trend in physical geography was carried on in the works of P. I. Brounov.

Brounov pointed out that physical geography is concerned with "the external envelope of the earth". He wrote: "Physical geography deals with the modern face of the earth, or rather with the modern physical structure of the earth's external envelope, which is the home of organic life, and those phenomena occurring in it...." He believed that the earth's envelope stems from the interaction and interpenetration of the lithosphere, the hydrosphere, the at-

mosphere and the biosphere. The study of these interactions "comprises one of the most important tasks of physical geography". D. N. Anuchin and A. N. Krasnov underlined that the study of both particular and general aspects of earth science formed a part of physical geography.

In the period we are considering economic geography as such did not exist; in its place was statistics, which was closely linked with geography. In the latter half of the 19th century, however, statistics converged with both economics and political economy. As I. V. Vernadsky (father of V. I. Vernadsky), a professor at St. Petersburg University, wrote in 1852, "statistics investigates the laws of society", whilst geography is concerned with the "laws of locality". But he also pointed to the close link between them. Many questions relating to statistics and economic geography were developed by the Free Economic Society. Although the Russian Geographical Society had a statistical department, it only carried out special investigations linked with economic, commercial and other of the population's activities. Economists and statisticians have therefore played an important role in investigating the geographic differentiation of the economy in Russia, particularly in agriculture. The works of P. P. Semenov, A. F. Fortunatov and D. I. Rikhter contain valuable material on economic zonation. D. P. Zhuravsky's monograph on the Kiev gubernia (1852) is a remarkable example of a systematic statistical description of the gubernias of Russia. The military statistical descriptions made by the General Staff were perhaps the nearest thing to economic-geographical investigations at that time. These works gave quite a comprehensive description of both nature and the economic activity of the population in the gubernias of Russia. They distinguished economic regions and assessed their potential in terms of natural, economic and manpower resources.

In the latter half of the 19th century extensive general geographic descriptions of Russia and its individual regions were produced on the basis of expeditionary research and the achievements of geography. Among such important works were the five-volume *Geographical and Statistical Dictionary of the Russian Empire* (1863-85), edited by P. P. Semenov-Tien-Shansky, the popular twelve-volume publication *Picturesque Russia* (1881-85) and the major multivolume work *Russia. A Complete Geographical Description*

of Our Country (1899-1913). A large team of Russian geographers worked on the latter publication, which gave a comprehensive geographical description of the country by regions determined by P. P. Semenov-Tien-Shansky. This work was a major contribution to geographical science. The collective work on Asian Russia published by the Migration Department and the books of P. A. Chikhachev (Asia Minor), N. M. Przhevalsky (Mongolia and Tibet) and D. N. Anuchin (Japan) were important monographic works of this period.

It is clear that the considerable achievements of Russian geography in the 19th and early 20th centuries, which were the result of extensive expeditionary activity, the opening up of new lands and the elaboration of many theoretical questions, represented a major contribution to the development of geographical science throughout the world. Russian scientists presented the results of their work at the International Geographical Congresses in Paris (1875) and Venice (1882).

Part II

THE DEVELOPMENT OF SOVIET GEOGRAPHICAL SCIENCE

THE EMERGENCE OF SOVIET GEOGRAPHICAL SCIENCE (1917-29)

In order to understand the difficulties faced by the young Soviet state after the Great October Revolution we should recall that tsarist Russia had no scientific geographical institutions as such. Neither was geography represented in the Academy of Sciences. There was no coordinated research; investigations were carried out by university professors and individual departments, which sometimes bore no direct relation to science. Such, for example, were the Naval Ministry, which organised circumnavigations of the globe and carried out various kinds of research on hydrography; the Foreign Ministry, which in cooperation with the Academy contributed to the success of Academician G. I. Landsdorf's ethnographic research in Brazil and M. I. Vronchenko's astronomical and geodesic investigations in Asia Minor; the Mining Department, which in addition to exploring for minerals carried out topographical surveys. Whilst pursuing their own departmental goals, these and other institutions helped raise the level of geographical knowledge and accelerated the progress of geographical science.

On the other hand the latter half of the 19th century saw a great increase in the role of societies as organisers of scientific work. In addition to the Geographical Society, which became the focal point of geographical investigations in Russia, the following societies were concerned with individual aspects of the natural environment: the Amateur Society for Natural Science, Anthropology and Ethnography and the Society of Investigators of Nature, which had close ties with Moscow University; the Societies of Naturalists or Lovers of

Nature, which functioned in all the universities of pre-revolutionary Russia; the Mineralogical Society, the Free Economic Society and a number of other similar organisations which did a good deal of work in the study of nature. In addition many district and other local organisations carried out various investigations and regional studies.

Apart from the scientific societies and organisations for regional studies, which with a few exceptions had negligible funds for research and publishing, there appeared several specialised institutions of an applied scientific nature, which accumulated geographical materials. The Geological Committee, institutions of the Ministry of Agriculture and State Properties, such as the Department of Agriculture, the Department of Land Improvements and, particularly, the Main Migration Department, carried out major investigations on relief, climate, the hydrology of rivers and inland waters and, especially, on vegetation and the soil cover. The Department of Merchant Ports of the Ministry of Commerce and Industry organised research and published materials on hydrometeorology. Finally, the Military-Topographical Department of the General Staff and the Main Hydrographical Department not only made accurate topographical surveys and compiled topographical maps and navigation charts, but published military-geographical descriptions of various regions of Russia and foreign countries and, like the societies, carried out geographical research of various kinds. Their results were published in various *Works*, *Notes*, *Proceedings* and *Materials*, which together comprised the basic fund of geographical knowledge accumulated by Russian science up to the time of the October Socialist Revolution. V. V. Dokuchaev, A. I. Vostokov and P. P. Semenov-Tien-Shansky and other prominent scientists achieved quite a high level of generalisations and methodological developments. Nevertheless the extent of their knowledge of the vast territory of Russia and, consequently, their grasp of its natural conditions and resources, its geography, economy and population varied considerably from one region to another and despite a number of important theoretical conclusions and generalisations were insufficient for the purpose of solving practical problems.

It is interesting to note that in spite of the lack of knowledge of the location, reserves and quality of various natural resources theoretical geographical thought outstripped the level of knowledge of individual natural components

and, by resorting to extrapolation and analysis of uncoordinated facts, was capable of formulating conclusions on the natural environment as a specific phenomenon of nature in which everything is interconnected and interdependent.

The First World War showed how scant was the knowledge of the country's natural resources and how poorly they were used.

To achieve coordination in research and bridge the gaps in the knowledge of natural resources, and to ensure their use in industry, technology and agriculture the Academy set up on the suggestion of a group of academicians (V. I. Vernadsky, A. P. Karpinsky, N. S. Kurnakov, B. B. Golitsin and N. I. Andrusov) the permanent Commission for the Study of the Natural Productive Forces of Russia (KEPS) under V. I. Vernadsky. The Commission was primarily concerned with collating the material which it already had in its possession; it also gave scientific advice to industrialists and state departments on the location, conditions of exploitation, use and processing of raw materials. Vernadsky believed that the next step should be the organisation of special expeditions to study natural resources and then the establishment of a network of special state institutions.

A special memorandum on this subject written by Vernadsky at the end of 1916 gave a boost to the plans for organising a number of research institutes, which were considered at a session of KEPS on January 10 (23), 1917. Previously, in 1915, a plan for a Central Geographical Institute drawn up by Professor of Moscow University D. N. Anuchin, a famous scientist and the founder of the Moscow school of geographers, was presented to the Preliminary Commission on the organisation of KEPS. It did not, however, win the support of the Academy leadership and was rejected on the purely formal grounds that the geographical study of Russia was not mentioned during the organisation of KEPS. Thus in the last years of tsarism the idea of reviving the Academy's activity in the field of geography was buried.

A completely different stand on this question was taken by the young Soviet state, which from the first months of its existence put forward new tasks for a systematic study of the country's natural conditions.

The socialist state began to employ science to tackle major economic tasks. In doing so the Soviet Government

not only made demands on science, but provided financial support, organised institutions and trained new personnel for them. The Academy of Sciences set about carrying out the first commission of the Soviet Government which was set down in Lenin's "Draft Plan of Scientific and Technical Work" on the elaboration of scientific subject-matters linked with the creation of the material basis of production, the study and exploitation of new coal, iron and oil deposits and water resources for power in industry and agriculture.

The results of research into productive forces achieved by the Academy of Sciences and other scientific establishments, higher educational institutions and scientific societies were used by the State Commission for the Electrification of Russia (GOELRO), which was set up on Lenin's initiative in February 1920 under the directorship of G. M. Krzhizhanovsky, subsequently an academician and vice-president of the Academy. In accordance with Lenin's proposal the Commission included many prominent scientists—naturalists, economists and economic geographers and engineers, who apart from helping to formulate the GOELRO plan took part in the work headed by M. I. Kalinin on organising the first network of economic areas of Soviet Russia.

In order to render GOELRO practical assistance in planning the development of the northern regions the Academy of Sciences held a special conference in May 1920 and took up the role of a coordinating centre. The conference heard more than 80 reports on various questions concerning the use of natural resources and the location of new enterprises in the field of heavy industry, transport, agriculture, forestry, animal husbandry and fisheries. This conference set a pattern for future conferences held by the Academy of Sciences and other scientific and governmental institutions which dealt with the same problems on a national, republican and regional scale.

In the new social and political conditions science soon became the concern not of isolated enthusiasts, but of large scientific teams set up to investigate and solve particular problems or seek new scientific methods.

The Industrial Geographic Department of the Academy of Sciences, set up as part of KEPS, was the first of the scientific geographical institutions established after the Revolution to fulfil the tasks set by the Soviet Government for a systematic study of the country. The main task of this de-

partment was to work out a detailed plan for the national organisation of the economy on the basis of the most rational use of all the country's resources; to perform the work necessary to draw up such a plan; to take national and local measures to help implement this plan and popularise it among the people.

These aims were pursued not only by the Industrial Geographic Department of KEPS, which was set up on May 4, 1918, and converted into the Geographical Department of KEPS five years later, but by the institutions established after it including the Institute of Geography which functions now under the USSR Academy of Sciences and is the country's main geographical research institute. It is this practical orientation of geographical research that differed the approach to science and demands made on it in pre-revolutionary Russia from those after the October Revolution.

Before the revolution economic geography was predominantly concerned with statistical and commercial research which provided information for the administrative and governmental apparatus and served the needs of the commercial and industrial bourgeoisie. But even then the progressive elements in tsarist Russia used the statistical data (particularly those obtained by the zemstvos, which Lenin held in high regard) as a powerful instrument to accuse the establishment.

The geography of pre-revolutionary Russia was mainly represented by general geographical or specialised economic works with information of an economic-geographical nature. By the time of the October Revolution works appeared in which either individual sectors of the economy were investigated, or an economic (economic-geographical) description of particular regions given. In educational institutions economic geography was taught as a number of subjects dealing with individual branches of the economy.

Thus in the first decades after the Revolution "economic geography was concerned almost exclusively with describing the economy by branches.... At that time this was the main scientific trend"* in the emerging Soviet economic geography, which subsequently became known as the sec-

* O. A. Konstantinov, *Sovremennaya sistema ekonomiko-geograficheskikh znanii v SSSR* (The Modern System of Economico-Geographical Knowledge in the USSR), Transactions of the Academy of Sciences of the USSR, Geography Series, No. 6, 1974.

toral-statistical trend or the Den school (after Professor V. E. Den, its leading theorist).

It was only after 1926, when N. N. Baransky published his *Economic Geography of the USSR. A Review by Gosplan* (the USSR State Planning Commission), *Regions,* that Soviet geographers began to base economic geography on new principles and started to consider an economic region "as a territorial-productive unit with specialisation on a national scale".

At the same time other institutions began to appear in the Academy of Sciences whose tasks included the study of individual components of the geographic environment. Their efforts, like those of the Industrial Geographical Department, were directed towards solving the primary task of the day, that is providing industry with the main raw materials from domestic sources.

There was a rapid rise in the number of new institutions. The Soil Department of KEPS was set up in April and May, 1918; this subsequently became the Dokuchaev Soil Institute. The Hydrological Department (later the State Hydrological Institute), the Salt Department, the Department of Rare Metals and the Department for the Study of the North and many other departments which later became independent scientific research institutions were formed within the framework of KEPS.

New institutions and special scientific expeditions designed to study the productive forces of the Soviet state also came into being at this time outside the Academy of Sciences. On July 2, 1918, the Council of People's Commissars passed a resolution (signed by Lenin) on the organisation of a hydrographical expedition whose job was "to make a thorough study of navigation conditions" along the Northern Sea Route and "ensure that such navigation became possible in the shortest time". This decision was followed by many other projects aimed at studying the Soviet sector of the Arctic and the northern regions of Siberia as well as opening an all-year-round navigation channel along the Northern Sea Route. In the spring of 1920 the Northern Scientific and Commercial Expedition was formed under the Supreme Council of National Economy; out of this grew the Institute of the Arctic and Antarctic.

In 1921 Lenin signed a special decree on the creation of the Floating Maritime Institute (Plavmornin) attached to

the People's Commissariat for Education. The main task of this scientific institute was to make a comprehensive and systematic study of the northern seas, islands and coastlines "of importance to the state at the present time". Plavmornin was commissioned to carry out research in biology, hydrology, meteorology and climatology, and investigate the geology of the USSR northern seas. In 1922 the first Soviet scientific expeditionary vessel *Persei* (Perseus) was built for the Institute. The investigations carried out by Plavmornin (now the All-Union Institute of Fisheries and Oceanography, VNIRO) laid the foundations for the development of Soviet oceanology.

Concern for the development of territorial investigations of Soviet Russia quickly led to the idea of establishing a coordinating centre for topographical and geodesical activities. With this end in view the Higher Geodesic Department (now the Main Department of Geodesy and Cartography to the USSR Council of Ministers) was set up on March 15, 1919. In a short space of time (by 1927-29) most of the country was covered by accurate and reliable maps of various scales which served as a solid basis for special explorations in the field of geology, soil science, water power resources, etc.

The need to provide the Soviet state's economy with information on the climate and waters was reflected in a resolution of the Council of People's Commissars (Sovnarkom) of the Russian Federation, drawn up in a decree signed by Lenin on June 21, 1921 on the formation of the Meteorological Service. The Soviet state also gave the requisite support to institutions which had been set up long before the Revolution, such as the Geological Committee and the Main Physical Observatory.

The work of such establishments as the Meadow Cultivation Institute and the Institute of Plant Growing, Applied Botany and New Cultures, which were set up in this period, and the corresponding departments and research institutes at a number of old and new universities was of great significance for the development of geographical research and the study of natural resources. The Institute of Soil Science and Geobotany attached to the University of Central Asia (founded in 1918 in Tashkent) played a major role in the study of Central Asia. When Irkutsk State University was opened in October 1917 (the second university in Siberia), the Biological-Geographical Institute was set up to organise a

study of Lake Baikal and the river Angara. This was the first institute of its kind in the world.

A particularly important role was played by the Geographical Institute—the country's first higher educational establishment specialising in geography, which was founded in December 1918 in Leningrad. The Institute brought together the leading geographers and attracted a vast number of young people interested in this subject. It was the first institution to introduce compulsory practical training for its students, which gave them the required experience and acquainted them with research methods. This practice was later adopted by all Soviet higher educational institutions, in which geographical or geological departments were established after the Revolution.

The combination of practical training and work on scientific expeditions helped produce a new type of researcher—a person inspired by the ideas and principles of a multiple and inter-disciplinary approach to the study of the country's nature and economy.

This approach was first formulated in 1921 when the Industrial Geographical Department of KEPS organised under A. A. Grigoryev the first multi-purpose physico-geographical explorations of the Bolshezemelskaya tundra with a view to possible development of animal husbandry in the North. The explorations were carried out on the instructions of and financed by the Northern Scientific and Commercial Expedition. The Department's next major multi-purpose expedition was concerned with investigating timber resources and reforestation conditions in the Southern Urals.

Complex geographical research was also organised by the Geographical Institute attached to Moscow State University. The Institute was established in December 1922 on the initiative of D. N. Anuchin.

Much of the research of that period was related to the construction of major industrial facilities provided for by the State Plan for the Electrification of Russia (GOELRO). This included the long-term multi-purpose research carried out by the Academy of Sciences in cooperation with other institutions. A major part of this work was done by a team of hydrologists who together with other specialists produced a technical project for the construction of the first Soviet hydroelectric power station (the Volkhov Station) which was built as part of the GOELRO plan.

The Academy of Sciences also oriented its scientific and field activity to the study of the country's productive forces, the exploration of new undeveloped resources and related issues. The Kola Multi-Purpose Expedition was typical in this respect. The discovery of a number of rare minerals made by this expedition stimulated the Academy's interest in the study of this region, which in Soviet times has been transformed from an undeveloped and almost uninhabited area into one of the most developed centres of the mining industry in the USSR.

Another major expedition of comparable scientific and practical significance was the multi-purpose expedition to Yakutia, which was organised by the Academy of Sciences at the suggestion of the government of the Yakut Autonomous Republic in 1925.

At the time the Academy of Sciences, with its highly-qualified experts and scientists, became the country's leading scientific centre. It focussed its attention on major economic problems: the reconstruction of economy in the central regions, the development of the northern territories, and the deserts and arid steppes of Central Asia. The Academy made wide use of new methods of complex research, particularly in such major operations as investigating the Kursk Magnetic Anomaly or exploring the resources of the Gulf of Kara Bogaz Gol. A large number of specialists, geographers among them, took part in this work. Their participation in every expedition became a common practice as well as wide use of methods of geographical analysis.

In January 1926 the Special Committee for the Study of Union and Autonomous Republics (OKISAR) was established under the Academy of Sciences so as to direct field activity more effectively. Two years later this committee became the Commission for Expeditional Research (KEI). The broad scope of the Academy's activities fostered the development of scientific work in the Union Republics and the formation of scientific centres there. For example, Academician A. Y. Fersman's Kara Kum Expedition in collaboration with the Turkmen Scientific Research Institute launched a study of Turkmenia and the Kara Kum which went on for many years afterwards.

During the period from 1926 to 1930 almost the whole territory of the Soviet Union was the subject of geographical research of a scientific and practical nature.

The 1920s also saw the start of an intensive study of the mountain regions of Central Asia and Kazakhstan. Apart from the work of the Academy of Sciences and its expeditions to the Tien Shan range a major part in this research was played by the University of Central Asia. The expeditions of N. L. Korzhenevsky were of particular interest. During one of these expeditions to the Fedchenko glacier in 1926 he discovered a ridge, which he called after the Academy of Sciences. This turned out to be the highest ridge of the Pamirs and Altai highlands with the highest mountain in the Soviet Union—the Peak of Communism (7,495 m).

Major discoveries were made in Eastern Siberia by S. V. Obruchev, who worked there between 1917 and 1924 on the instructions of the Geological Committee. To the north of the Eastern Sayans in the Central Siberian Plateau he discovered the Tungus coal deposit, the largest in the world. Obruchev's discovery of the Chersky Ridge in 1926, made in cooperation with K. A. Salishchev, in the course of geological and topographical and geodesic investigations, was of tremendous significance for the development of the modern orographic picture of North-Eastern Siberia.

Theoretical research of this period can be represented by G. I. Tanfilyev's summary description of the country's physical geography, and a number of monographs on individual components of the USSR's natural environment.

A. D. Arkhangelsky's "Introduction to the Study of the Geology of European Russia" gave a boost to the development of geomorphology, paleogeography and tectonics. V. A. Obruchev's summary report had a comparable impact on the study of Siberia and the Soviet Far East. It was first published in Berlin in 1926 (in German) and appeared in a somewhat larger edition one year later in Leningrad (State Publishers).

Of the summaries on the country's soils special mention should be made of Academician K. D. Glinka's *The Soils of Russia and Neighbouring Countries*. L. I. Prasolov's *Soil Regions of European Russia* and *Cartography of Soils* showed that "even on the plains of Eastern Europe the local conditions of soil formation in each soil zone determine predominant and constant combinations of elements of the geography of soils." "Zonation of such natural regions according to soils," wrote on Prasolov, "would be of great practical significance for all branches of the economy linked with the

land." Prasolov used the same criteria for judging of the scientific and practical significance of soil research when compiling two soil maps: his map of the Asian part of the USSR (scale 1:4,200,000), which he completed in 1925, and his map of the European part of the country (1:2,520,000) of 1927.

The works of N. A. Bush and V. L. Komarov, as well as "Essays on Siberian Vegetation" written by the head of the Tomsk school of geobotanists P. N. Krylov were the most important in the field of botanical geography. In the field of zoological geography two major summary papers appeared in the 1920s: V. V. Stanchinsky's work on birds and L. S. Berg's *Fresh Water Fish.*

A good deal of interest attaches to the climatic zonation of P. I. Brounov and A. A. Kaminsky, and to V. G. Glushkov's work on geographical methods of calculating water runoff in the absence of complete hydrological and meteorological data. In 1927 M. I. Sumgin's *Permafrost Areas in the USSR* was published in Vladivostok. This book had an important influence on the subsequent development of a new science—permafrostology.

Thus in accordance with Lenin's plans the work of the twenties paved the way for wide-scale geographical research and the growth of the Soviet Union's geographical institutions which, first and foremost, were designed to provide basic data for the planning and distribution of the country's developing economy.

GEOGRAPHY IN THE PRE-WAR FIVE-YEAR PLANS (1929-41)

By the late 1920s Soviet geography had achieved considerable success. More than a decade of research organised by various commissions of the USSR Academy of Sciences with the primary aim of studying the resources of the Union Republics—once backward provinces of Russia—had seen the collation and publication, mostly in the works of regional academic expeditions, of a vast amount of factual material on the country's nature. During this period the Geographical Department of KEPS was strengthened, research workers were trained and experience of field work accumulated. Close contacts developed between head scien-

tific organisations and regional and republican economic and Party authorities.

In 1929 the State Meteorological Service was set up to embrace all the republican, territorial and departmental services, including marine hydrometeorology. Together with the network of weather stations, observatories and forecast bureaux the Meteorological Service drew in and strengthened research bodies specialising in the study of the atmosphere, and the hydrology of the land and seas. At the time the interdepartmental Committee for the Study of Permafrost was established.

Among the summary works which appeared at the end of the 1920s we should single out the new geological maps: A. V. Voznesensky's climatographic map of the USSR; new works on the soil and vegetative cover; Y. M. Shokalsky's altimetric map of the country with a scale of 1:12,000,000.

L. S. Berg successfully developed V. V. Dokuchaev's doctrine on zonation and in 1930 published the first volume of *Landscape Geographical Zones of the USSR* which deals with the tundra and forest zones, and the forest-steppe. Apart from summarising a great deal of factual material on various natural components and classifying it on the zonal principle Berg set down the basic concepts of landscape science as a complex of objects and phenomena, in which the features of relief, climate, water bodies, soil, flora and fauna, and man's activity form a balanced unity typical of the given zone. Although a number of scientists criticised some Berg's views (like Getner, he considered geography a chorological science) a whole generation of Soviet geographers were brought up on his works.

At the same time a struggle was going on in economic geography between the advocates of the sectoral-statistical ("traditional") approach and those who considered economic geography a purely economic science and refuted its close link with the geographical approach, on the one hand, and with the regional, "Gosplan" approach (supported by the Gosplan—State Planning Commission) on the other. It was in the course of this struggle that Soviet economic geography developed.

The thirties proved to be a turning point in the development of Soviet geography in terms of organisational and theoretical activity and scope of research. The tremendous amount of work to industrialise the country's economy under-

taken as part of the First Five-Year Plan (1929-33) set new tasks before science, and made new demands on its organisation, contents, and forms of application and dissemination of knowledge. This was particularly true of geographical science.

First and foremost the planned economy was to be provided not only with data on resources and conditions for agriculture and forestry, but information on mineral raw materials, water power resources and the conditions of life in the newly-developed areas. It was also essential to select routes for surface communications.

In addition it was necessary to raise considerably the cultural level of the population, particularly in the remote parts of the country, and train a vast army of specialists to work in economic, planning and design organisations. Geography was thus faced with three interrelated tasks: to carry out practical research for economic development; to train personnel for this purpose (both specialists with general geographical education and experts on individual republics, districts, regions, or sectors of the economy); to raise the general cultural level. In the pre-war period geographical research was carried out by the USSR Academy of Sciences and its various institutions, by higher educational establishments, numerous planning, design and economic organisations, and often by special scientific research institutions established under their direction. Specific research on individual regions and republics and the study of these areas by expeditions went hand in hand with work on theoretical problems linked with the distribution of production enterprises.

In 1930 the Council for the Study of Productive Forces (SOPS) was formed from KEPS (Commission for the Study of the Natural Productive Forces of Russia), KYR (Commission for the Study of the Yakut Autonomous Republic) and KEI (Commission for Field Research) to coordinate and direct investigations on the country's natural conditions and resources.

This period also saw considerable changes in the position of geography in the Academy of Sciences. In 1930 the Geographical Department of KEPS was transformed into the independent Geomorphological Institute of the USSR Academy of Sciences. New issues were included in the research programme of the Baikal Biological Station which in 1933 became the Limnological Station. Multi-purpose geographical

research was undertaken by the Forestry Institute and the Sand and Desert Institute which existed for a short period of time, as well as by the Pacific Ocean Committee and the Polar and the Mongolian Commissions. In 1931 a geographical group was set up within the Department of Mathematics and Natural Sciences to coordinate all geographical research in the Academy of Sciences. The following year this became the Geographical Association.

The Geomorphological Institute was in no way limited to the study of relief. Its staff produced the first post-revolutionary series of regional monographs on the development of the relief of the Pamirs, the West Siberian Plain, the Minusa Hollow, Central Siberia, the Northern Urals, Transbaikalia and other parts of the country. The information obtained on relief that has a considerable influence on other elements of landscape shook the belief in the universality of zonal regularities in the differentiation of nature. The works of other specialists, primarily those of soil scientists S. S. Neustruev, G. N. Vysotsky, B. B. Polynov and I. P. Gerasimov, also showed that zonation is not just based on a simple correspondence of the soils and vegetation to the earth's climatic and solar radiation zones, but is governed by more complex laws. Geographers began to concentrate more and more on research into these laws. In outlining the tasks of the Geomorphological Institute of the Academy of Sciences, A. A. Grigoryev wrote in his article "Physico-Geographical Study of the Union" (1931) that the emphasis should be shifted from descriptions and interpretations to research on the complex natural processes which determine the features of the environment. At the same time it was necessary to "determine the qualitative and quantitative pattern of interrelations and links" and obtain essentially new characteristics of each type of geographical environment. Thus began the formation of complex, or general physical geography, and its two branches—landscape science and earth science. Their emergence in Soviet geography is linked with the publication in 1932 of two articles, the first of which—"On the Objects and Methods of Physical Geography" by M. A. Pervukhin—treated landscapes as real natural complexes, and the second—"The Object and Tasks of Physical Geography" by A. A. Grigoryev—outlined for the first time the concept of geographical envelope of the earth as a space where inter-penetration of the lithosphere,

atmosphere and hydrosphere takes place. They both stressed the importance of investigating the processes by which the geographical envelope is differentiated and natural complexes are formed, and by which the interrelations between their components occur.

N. N. Baransky (1881-1963) is generally regarded as the founder of Soviet economic geography; the methodological concepts contained in his works (of which there are over 500) serve as a theoretical basis of this science. Baransky was not only a prominent scholar and tireless researcher and innovator: he was also one of the old-guard of Russian professional revolutionaries, who laboured and struggled throughout his life. Baransky gave lectures to students of Sverdlov Communist University, Moscow University, the teacher training institutes in Moscow, Leningrad, Alma Ata and many other cities, the Higher Party School, the Lenin Courses, the Higher Diplomatic School, the Institute of World Economy and International Politics, the Institute of International Relations. He participated in the work of numerous congresses and conferences. As the author of the first standard textbook on the economic geography of the Soviet Union which ran into sixteen editions and was awarded the USSR State Prize, Baransky taught geography to students of two generations.

Operational activity to meet the needs of economy as well as theoretical and methodological research went hand in hand with major expeditions to almost inaccessible regions. Their discoveries changed the existing ideas on the country's relief and hydrology. In the early thirties the most significant explorations in this respect were those made of the mountain glaciers of the Pamirs and the Altai, where the major rivers of Central Asia take their rise; the study of the Severnaya Zemlya archipelago; the work of the Chukotka airborne expedition, which after the discovery in 1926 of the Chersky Ridge described other elements of the mountainous relief of the Soviet North-East.

Further investigations were carried out in the Arctic both as Soviet contribution to the Programme of the Second International Polar Year, and with the aim of developing the Northern Sea Route, which was first navigated in one season by the ice-breaker *Sibiryakov* in 1932.

To keep pace with the growing needs of research on the country's nature and economy it was essential to increase

the number of qualified geographers. To this end a faculty of soil and geography was opened at Moscow University in 1932 to produce geographers with a general background in this subject.

Training specialists in economic geography was started at Leningrad and Moscow universities in 1930 and 1931 respectively. The economic geography section of the Leningrad branch of the Communist Academy (LOKA) was for a long time the centre of scientific thought. From 1932 onwards it ceded this position to the Geographic and Economic Research Institute (GENII) at Leningrad University. These two institutions were mainly concerned with teaching matters and were for many years cut off from the operational activity of economic development, having few contacts, if any, with planning organisations. Later they organised expeditions to the north-west of the Russian Federation and helped compile the *Atlas of the Leningrad Region and the Karelian ASSR.* Leningrad researchers published a number of books in a series entitled "Economic Geography of the USSR by Regions".

At that time Moscow started to successfully compete with Leningrad as the country's main scientific centre for economic geography and soon took its place. Leading scientists began their work in the economic geography section of the Communist Academy in 1925; later, in 1929, the focal point moved to the Department of Economic Geography and to the Geographical Research Institute at Moscow University. The geographical faculty of Moscow's Lenin Teacher Training Institute was also active in economic geographic research after 1927. The work of these institutions was co-ordinated by N. N. Baransky who invited a number of well-known economic geographers to assist him in his task. They included: L. L. Nikitin, S. V. Bernshtein-Kogan, L. D. Sinitsky, N. N. Kolosovsky, I. A. Vitver, P. N. Stepanov and L. Y. Ziman.

In 1929 the Department of Economic Geography published its famous "Economic Geographic Collection" in which the leading Soviet economic geographers of the day, who had developed the regional trend in economic geography, set down their fundamental scientific ideas on the methodology of this science. At the same time the Communist Academy published its series of textbooks on the economic geographic regions of the USSR as defined by the Gosplan.

The professorial staff of Moscow University was in this period preparing reforms in the teaching of geography in the Soviet Union.

April 1933 saw the convention of the First All-Union Geographical Congress which was designed to coordinate the efforts of geographers throughout the country. The Congress summarised the results of geographical research carried out in the 15 years since the Revolution, and discussed its future activity and various questions of methodology. Speaking on behalf of the economic geographers of the Academy's Institute of Economics and Moscow University's Institute of Geography N. N. Baransky proposed that they bring out a series of monographs on the regions, territories and republics of the USSR, highlighting the related natural, economic and cultural features. The Congress also set the country's geographers the task of compiling a "Complete Geography of the USSR".

At the same forum A. A. Grigoryev spoke about the need for research into the physical geographic process and, particularly, the exchange of matter and energy using both qualitative and quantitative methods. M. A. Pervukhin raised the question of compiling maps showing various types of landscape zones.

The large-scale economic development of the country required a higher level of general geographical knowledge. The Resolution of the Communist Party Central Committee of October 5, 1931 therefore made knowledge of geography compulsory for entry into higher educational and technical colleges and institutions. On May 16, 1934 the Sovnarkom of the USSR and the Communist Party Central Committee adopted a special resolution "On the Teaching of Geography in Primary and Secondary Schools", which made provision for the doubling of the number of hours taught, the preparation of new textbooks, and the training of geography teachers in the universities and teacher training colleges.

This resolution had a tremendous influence on the development of Soviet geography. It laid the foundations for a network of geographical faculties and departments in the universities and teacher training institutes—a network which still exists today. Teams of geography specialists appeared not just in the republics, but in most large regional and territorial centres. Besides training geography teachers these teams studied the geography of their own republics, territo-

ries and regions, thus supplementing the research carried out by the central, primarily academic institutions.

The scientific and methodological journal *Geography in Schools* appeared for the first time in 1934 under the editorship of N. N. Baransky. It soon became the main publication not only for teachers, but for many experts, especially those working in the field of economic geography. The journal contained articles on general methodology and geography.

In the same year the Academy of Sciences was reorganised and its centre moved to Moscow so as to establish closer contacts with government and central planning organisations, and design institutions. At the end of 1934 the Geomorphological Institute of the USSR Academy of Sciences was converted into the Institute of Physical Geography. Two years later it became the Institute of Geography of the Academy of Sciences after its scope had been broadened to include new subject-matters and departments of economic geography* and cartography, and a commission on aerial survey had been established. In the mid-1930s the Institute organised field research connected with the development of new territories, the construction of water power stations on the Kola Peninsula, in Karelia and on the Angara River, railway construction in Eastern Siberia, land improvement in Polesye and irrigation in Central Asia.

Besides taking part in the field research the staff of the Department of Economic Geography carried out theoretical research, mainly on the location of various industrial and other enterprises. We can single out A. Y. Probst's monograph "Fundamental Problems Associated With the Geographical Location of the Soviet Fuel Industry" of 1939 as the most successful example of research of this type.

In the early thirties the major academic expeditions, staffed by SOPS from the central institutions of Moscow and Leningrad, were the principal form of complex research on nature. Many of these expeditions were confined to the study of one particular region; it was their job to survey the region, investigate various aspects of its nature and determine which natural resources it possessed with a view to further

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* The department was formed as a result of the merger of the Academy of Sciences and the Communist Academy which had previously been involved in research on social sciences.

development. This period saw such major expeditions as those to the Kola Peninsula (before 1930), the Kulunda region (1931-33), Kirghizia (1932-33), the Kara Kum (1929-30), Turkmenia (1934-36), and Tajikistan and the Pamirs (1932-36). The significant discoveries in orohydrography of the mountain regions of the country and other findings by the expeditions were summarised in the many-volumed series: *The Works of SOPS* and other publications.

In the mid-1930s the Academy of Sciences published in co-operation with a number of other organisations a series of works on the SOPS multi-purpose expeditions related to major construction projects. These included "The Greater Altai" (1934-36), "The Greater Dzhezkazgan" (1935), "The Greater Emba" (1937-38), "Karaganda—the Third Coal Centre of the Union" (1936) and "The Agriculture of the Altai Mining Region"; "Atlas of USSR Energy Resources" (1933-35); the monograph "Energy Resources of the USSR" (1937-38); the regional ecogeographical monographs of A. N. Rakitnikov—"The Central Tien Shan and the Issyk Kul Hollow. The Principles of Developing Cattle-Breeding in Mountainous Areas" (1936), and M. G. Sakharov—"The Settlement of Nomadic and Semi-Nomadic Economies of Kirghizia" (1934).

Large-scale regional conferences were organised at the time on the development of productive forces so as to apply as rapidly as possible the results of the SOPS field research. The scientists, Party and Soviet workers, and representatives of agriculture and industry drew up draft plans for the development of socialist economy for Union and Autonomous Republics and the use of their natural resources. In the thirties such conferences were held in Transcaucasia, Daghestan, in all the Central Asian Republics, in Oirotia, Buryat Mongolia and in the Ukhta-Pechora Territory. Publication of the works arising out of these conferences became a generally accepted practice throughout the country.

In the early thirties all branches of geography made considerable progress both in theoretical and practical research related to economic development; not only regional monographs but new theoretical works made their appearance at that time.

Meteorologists widened their range of observations of atmospheric phenomena and processes. Using new and old materials on the principal aspects of climate the Main Geo-

physical Observatory continued its series of monographs "Climates of the USSR", and in 1931 and 1932 published "Reference Book on the Climates of the USSR".

Oceanographic research assumed great proportions in the pre-war five-year plans. The Hydrometeorological Service of the USSR established meteorological institutes along all the country's coastlines, so supplementing the Academy of Sciences' network of marine research establishments. Important marine research work was undertaken by the State Oceanographic Institute and the Arctic Institute, institutions of the Hydrographical Service of the Navy, and by the fishing industry. Y. M. Shokalsky's monograph "Physical Oceanography" reflected the high level attained by Soviet science in this field.

The Programme of the Second International Polar Year played an important part in oceanographic research. In 1932 and 1933 expeditions were organised simultaneously in all the seas around the Soviet Union to gather new information according to an agreed programme. Considerable progress was made in the study of the northern seas by the Northern Sea Route Office which was established for their exploration and development. The voyages of the icebreakers *Sedov, Sibiryakov, Malygin* and, subsequently, *Chelyuskin* whose heroic crew was rescued from an ice floe wrote a fascinating chapter in the history of Arctic exploration.

Glaciological research in the USSR during this Polar Year Programme was carried out not only on polar glaciers, but in all the mountain glacier regions. The results of this complex geographical research were published in the six-volume "Works of the Glaciological Expeditions of the Second International Polar Year" of 1935-36.

Hydrologists tackled the problems of water supply for such major projects as Magnitogorsk, Karaganda and Turksib, worked on the Belomorkanal and Moscow Canal projects, helped design water power stations and irrigation systems, often in regions where no previous research had been done on water resources. The absence of long-standing observations was made up for by the application of calculation methods, in particular the hydrological and geographical method elaborated at the State Hydrological Institute under its director and scientific leader V. G. Glushkov. The first long-range forecasts were made of the water regimes of

major rivers in the European part of the USSR (V. N. Lebedev) and Central Asia (L. K. Davydov).

Stationary methods of observation were introduced primarily to study the hydrometeorological components of nature; Soviet scientists made a number of significant new developments in observation methodology. In 1930 P. A. Molchanov invented the radiosonde which did a great deal to advance the science of air-climatology; M. A. Velikanov had the idea of setting up experimental stations to observe the formation of river flow.

In view of the fundamental transformation of agriculture —the organisation of large state and collective farms—soil research was carried out in this period over vast areas of the Soviet Union. L. I. Prasolov and I. P. Gerasimov developed the notion of soil geographical provinces and soil-climatic facies which along with the concept of horizontal and vertical zonation formed the theoretical basis for the geography of soils. L. I. Prasolov and his co-workers compiled soil maps of the USSR and other countries of the world.

Geobotanical research, which was normally carried out in conjunction with soil research, covered vast territories in Central Asia, Kazakhstan, Siberia, the Soviet Far East and the Far North. This research, which maintained the great traditions of Dokuchaev's expedition, was aimed at finding new farmland and implementing land management. A great deal of work was done on the study of meadows for haymaking, pastures and marsh vegetation, and on the evaluation and taxation of forests and the determination of peat reserves. As a result of this work extensive data was obtained on the typology, productivity and geography of the vegetative cover, which was reflected in a number of maps and regional monographs, and in summaries on the country's meadows and marshes.

Research into the country's fauna also became better planned at the time. It covered the whole of the Soviet Union and even extended to a number of neighbouring countries. The range of fauna studied was widened to include, in addition to game, such things as soil fauna, vermin, disease-carriers, etc. Soviet scientists turned their attention to the zonation of land and water fauna, and to research on individual faunal complexes: their origin, evolution, ecology and relation to various landscape elements.

Thus during the first five-year plan the wide-ranging general and specialised research on nature and resources was mainly aimed at advancing socialist construction and meeting practical needs. This stimulated the development of sciences and increased the geographical knowledge of the country. In the thirties the growing demands made on research into natural resources strengthened the role of local scientific bodies. New research centres were established in various parts of the country, particularly in the Union Republics, their activities being directly connected with those of the central academic expeditions. Many prominent figures of Soviet natural science, including geographers, made a great contribution to their organisation, outlined the direction of their scientific research and helped in the training of their local counterparts.

Regional centres of the USSR Academy of Sciences, subsequently affiliated to it, were established in all the Central Asian Republics, in Kazakhstan and Transcaucasia. They formed the basis for the republican academies of sciences. In the Russian Federation scientific centres sprung up in the European North (the Kola, Karelian and Komi subsidiaries of the USSR Academy of Sciences), in Siberia and the Far East (the East Siberian, Yakut, and Far Eastern subsidiaries), in the Urals, the Northern Caucasus and in a number of Autonomous Republics. Many of these subsidiaries set up geographical departments and started research in this field. In addition to this network of academic centres there appeared a number of educational and departmental institutions in the republics and large regions. They did research on individual aspects of nature (geology, meteorology, forestry, etc.) or undertook complex sectoral investigations for the purposes of agriculture, construction of hydroelectric power stations, etc. The fact that in 1935 the USSR Academy of Sciences admitted its first two geographers—N. P. Gorbunov and O. Y. Shmidt—points to the growing role of geography at the time.

The growing rate of industrialisation required more quantities of traditional and new raw materials to ensure complete economic independence in the shortest possible time. In the pre-war period the Academy's multi-purpose expeditionary research played an important part in this field. It was designed to assist in solving major economic problems, particularly the use of natural resources and the develop-

ment of new regions in the east and north, which although little studied held out great prospects for the future. Here vast economic complexes were built from virtually nothing.

The monograph "The Ice Age on the Territory of the USSR" of 1939 had a great influence not only on the development of geomorphology and paleogeography, but on the use of geographical methods in the study of the Quaternary Period. This was the first work to analyse from a geographical standpoint the complex of processes associated with the Ice Age both in and beyond the glacial regions.

S. V. Kalesnik summarised the main scientific results of glaciological expeditions, including those of the Second International Polar Year, in his "Mountain Glacial Regions of the USSR" of 1937.

One of the founders of permafrostology M. I. Sumgin summarised the information on permafrost and outlined the future development of the science in his "Permafrost Soils in the USSR"; its second, supplemented edition came out in 1937.

G. T. Selyaninov and other climatologists wrote a number of summary works on agroclimatic zonation. S. P. Khromov's "Introduction to Synoptical Analysis" was published twice, in 1934 and 1937. The State Hydrological Institute produced a voluminous publication entitled "Water Cadastre of the USSR" (1935-40) under the guidance of V. G. Glushkov. D. L. Sokolovsky and B. A. Zaikov analysed the relationships between river discharge and climatic and other factors which were important in hydrological forecasting.

In summarising the results of geographical soil research the staff of the Dokuchaev Soil Institute of the USSR Academy of Sciences produced, together with soil maps, a three-volume monograph entitled "Soils of the USSR" (1939).

The two-volume publication "Vegetation of the USSR" reviewed the basic types of vegetative cover in the Soviet Union (tundra, bogs, meadows, steppes and deserts). Reviews on the country's marshes and peat-bogs were published by V. S. Dokturovsky (1935), M. I. Neishtadt (1938) and Y. D. Tsinzerling (1938).

B. K. Shtegman's "Principles of the Ornithogeographical Division of the Palaearctic" substantiated the general concept of the types of fauna which differ from each other in their place of origin and history of evolution.

The progress made in all the geographical sciences in the twenty years since the Revolution and the achievements of Soviet cartography were reflected in the *Great Soviet Atlas of the World* (1937), which Lenin himself had been instrumental in pioneering.

General physical geography, particularly earth science, continued to develop. In 1937 A. A. Grigoryev brought out a short work entitled "Experiment in Describing Analytically the Composition and Structure of the Earth's Physical Geographical Envelope" which the author regarded as a kind of introduction to general earth science. The book analyses the integrity of the geographical environment which is determined by the physical and chemical properties of its component elements. Grigoryev describes the physical geographical envelope as belonging to both the earth and outer space; he deals with its structure, forms of interaction with outer space, on the one hand, and the interior of the earth, on the other, examines energy flows, analyses individual elements of the geographical envelope and the interactions between them which involve matter and energy transformations.

A series of articles by the same author entitled "Experiment in Describing the Basic Types of Geographical Environment" in the equatorial, tropical, Arctic, sub-Arctic and temperate zones carried on the work of Grigoryev. In this series the author analyses various causalities—from the balance of radiation energy and temperature conditions, to the dynamics of atmospheric processes, the regime and dynamics of natural waters, and finally to the biocomponents and the balance of living matter.

The organisation of studies on the USSR also made great strides forward during this period. In 1935 the Committee for the Preparation of a Complete Geographical Description of the USSR was set up under the auspices of the Presidium of the Academy of Sciences, on the recommendation of the Bureau of Economic Research (chairman S. G. Strumilin). The following year the Committee was replaced by the Chief Editing Department with chairman V. L. Komarov, the President of the Academy of Sciences, and vice-chairmen N. N. Baransky and N. P. Gorbunov. In 1937, however, the preparation of "Geography of the USSR" was entrusted to the Academy's Institute of Geography, which from that time on was the centre for studies of the USSR.

Preparation of several publications was started; these included: the single-volume "Geography of the USSR", an eight-volume publication of the same name which described the country's nature, population and economy, and a 28-volume series of essays entitled "Nature of the USSR". The manuscripts were soon ready, but the books were not published due to the outbreak of the Great Patriotic War. Some of their material was, however, used in post-war publications.

As far as studies of foreign countries were concerned, the principal role in the pre-war period was played by Leningrad and Moscow Universities. In 1934 a department of economic geography of foreign countries was set up at Moscow State University under I. A. Vitver. Among the works which it produced were a textbook entitled "The Capitalist World" (1934) by L. I. Ziman; three books by I. A. Vitver—"Brazil and Argentina" (1930), "The Caribbean Countries" (1931) and "Germany and Poland" (1939); "China" (1940) by P. P. Glushakov; and "Spain"(1938) by I. O. Magidovich. Of the works prepared in Leningrad mention should be made of "Economic Geography of Asia" (1940) by V. M. Shtein and "Australia" (1937) by A. G. Mineikovsky.

In 1932 Moscow University sent at the request of design organisations major transport and economic expeditions to the Urals and Western Siberia, and then to the North (1934), the Buryat-Mongolian Autonomous Republic and Southern Kazakhstan (1935-36), to the Kuibyshev region, and to the Tartar, Mari and Chuvash Autonomous Republics. In addition multi-purpose expeditions were sent to study the Moscow (1935), Kalinin (1936-38) and Ryazan (1938-40) regions.

Other Soviet higher educational institutions carried out economic geographical field research: Leningrad University studied the Far East; Tomsk University investigated the North in the area of the Yenisei River; the University of Central Asia did research in Kirghizia; Moscow's Lenin Teacher Training Institute surveyed the Kursk region. The results of this field research were published in special collections and journals.

The pre-war period saw a good deal of economic geographical research carried out by the staffs of various central and local economic, planning, design and particularly publishing organisations. This applied specifically to the USSR State Planning Commission (Gosplan) which had on its staff

such researchers as N. N. Kolosovsky, L. P. Nikitin, A. I. Lerishchev and V. F. Vasyutin, and the Planning Commissions of the Union and Autonomous Republics, to organisations concerned with the planning and reconstruction of cities and regional planning, to the editorial staffs of the Great Soviet Encyclopaedia and the Great Soviet Atlas of the World, and to numerous local studies organisations. Books and brochures, both for the scientist and the general readers, were published on individual republics, regions and cities. The most successful of these were the books of N. N. Mikhailov, such as his "The Changing Face of the Country. A New Geography of the USSR" (1937). They were the first to inform the foreign reader of the tremendous economic and cultural changes taking place in the USSR.

Local planning organisations also published individual monographs on economic geography; in 1937, for example, M. I. Pomus' "The Buryat-Mongolian ASSR. An Economic Geographical Description" made its appearance. A series entitled "Regions of Central Asia" was also published at the time.

The increasing scope of geographical research and the growing number of geographers and geographical institutions called for more efficient coordination of their work. In 1938 the Department of Geological and Geographical Sciences (OGGN) was established within the Academy of Sciences. That same year the State Geographical Society, which had previously been under the People's Commissariat for Education of the Russian Federation, was by decision of the Presidium of the USSR Supreme Soviet placed under the Academy of Sciences and renamed the All-Union Geographical Society.

At the end of the thirties the wide application of aerial photographic surveying and the introduction of stereophotogrammetry for production of large-scale topographical works enabled maps to be compiled of distant and almost inaccessible regions of Siberia, the Far East, Central Asia, Kazakhstan and the Far North.

Aerial photography made it possible to obtain a clearer idea of the relief of deserts (B. A. Fedorovich), reveal new elements of orography, glaciers and volcanoes (e.g., the Anyui Volcano in the north-east of the country).

In 1937 O. Y. Shmidt led an aerial expedition to the North Pole during which I. D. Papanin, Y. K. Fedorov,

P. P. Shirshov, E. T. Krenkel—the legendary crew of the first Soviet drifting station "North Pole"—landed on the ice. Finally, in the spring of 1941, the region of the "Pole of Relative Inaccessibility" was surveyed from an aeroplane—the first to be used as a flying laboratory. These investigations proved conclusively that there is no land in the region of the North Pole, clarified the bathymetry of the Arctic Ocean and showed that at great depths the warm currents of the Atlantic penetrate far to the north.

In the pre-war years the USSR Academy of Sciences started research on the country's natural historical zonation in which many leading institutes took part.

GEOGRAPHY DURING THE GREAT PATRIOTIC WAR (1941-45)

Geographers made a great contribution to the war effort during the difficult years of struggle. There was, of course, a drastic change in the scope and orientation of geographical research. General geographic work was considerably curtailed and some research projects were suspended for a number of years.

Many geographers, particularly the younger ones, enlisted in the army. After retraining some of them joined the ranks of military engineers, meteorologists, geodesists, aerial photographs' readers, etc. All of them saw action during the war. Many Soviet geographers were awarded military decorations, and the majority of geographical institutions, both scientific and educational, honour the memory of those who did not return on memorial plaques.

In the first days of the war a number of commissions were set up within the Academy of Sciences; soon these joined together to form the Commission on the Geological and Geographical Service of the Red Army, one of whose directors was A. Y. Fersman. Geography was required to carry out a number of new tasks; the work often proceeded on the instructions of the Council of Labour and Defence and the Soviet Army Command. The mission was to service the needs of the front, produce the information and materials necessary for military actions, and determine resources in the rear.

To guarantee the normal functioning of science in wartime and safeguard leading scientists the Soviet Government

evacuated many scientific and higher educational institutions from the western and central regions of the European part of the country to the rear, where scientific work continued at local subsidiaries of the USSR Academy of Sciences or republican academies, and in universities.

The armed forces made varying demands on geography: geographers were required to provide geographical data on various theatres of war; they had to assess the seasonal passabilities of various territories and the seasonal change of colour of the natural and man-made landscape for camouflaging; special interest attached to features of the snow cover as a factor in military operations on the land and in the air. Special demands were made on geographers as regards descriptions of climatic and particularly flying conditions. In addition special methods had to be developed for interpreting aerial photographs.

Geographers from such institutions as the Academy of Sciences of the USSR, the Hydrometeorological Service, the Main Department of Geodesy and Cartography and specialised military services were instrumental in solving these problems.

Geographical work aimed at supplying the necessary information to the front took place in different conditions, on different scales and in conjunction with military organisations. The State Hydrological Institute drew up operational plans for forced crossings and carrying out military actions in lake and marsh-ridden regions. The advice of geomorphologists and soil scientists and others was sought in the building of fortifications. Soil scientists also helped select sites for aerodromes and developed methods for improving their surfaces.

Soviet geographers in the rear made an equally valuable contribution to the war effort. Their job was to find new resources for industry, find arable lands to make up for the areas temporarily occupied by the enemy and determine sites for industrial and transport construction projects.

The Academy of Sciences drew up a plan for war-time scientific work, which also included geographical research. A commission was set up in Sverdlovsk under the Academy's President V. L. Komarov to coordinate research on the use of the Urals' resources. In 1942 the commission included Siberia and Kazakhstan in its sphere of activity.

Many members of staff of the Institute of Geography, who

were evacuated to Alma Ata, together with their local counterparts and the personnel of the Soil and the Botanical Institutes of the USSR Academy of Sciences, took part in research on resources for the development of agriculture in Kazakhstan. As a result recommendations were made on the most efficient use of the land of Kazakhstan. This research was later extended to Northern Kirghizia, the Altai Territory, Ferghana, and the Omsk, Chelyabinsk and Kurgan regions.

The Academy of Sciences organised a major multi-purpose expedition in the Caucasus. Here, apart from prospecting for minerals and organising mining, the expedition determined arable lands and phytoresources.

Teams of Soviet economic geographers also worked on important defence problems. They studied resources of minerals, land, water and manpower in the eastern regions, especially Siberia and the Urals, and the possibilities of locating here new industries to meet the needs of the front.

There was an upsurge in the activity of local teams of economic geographers, especially in Kazakhstan and the Central Asian Republics, whose ranks were strengthened by highly-qualified personnel from the central research establishments and higher educational institutions.

Work continued during the Great Patriotic War on the analysis of previously accumulated materials, and on the compilation and improvement of maps, etc. Geographic journals appeared, although not on a regular basis. These included: "Proceedings of the All-Union Geographical Society" and "Proceedings of the USSR Academy of Sciences", "Geophysical and Geographical Series". Results of research begun before the war were prepared for publication. Materials produced before and during the war were used immediately after victory had been won.

The Great Patriotic War brought about tremendous changes in the distribution of industry in the Soviet Union. New industrial centres appeared in the Urals and particularly in Siberia, Kazakhstan and the Central Asian Republics. These changes in the country's economic geography were analysed by N. A. Voznesensky in his "Military Economy of the USSR in the Patriotic War" (1947).

GEOGRAPHY DURING THE POST-WAR PERIOD OF REHABILITATION AND DEVELOPMENT OF THE COUNTRY'S ECONOMY (*FROM 1945 TO THE EARLY 1960s*)

Interest in geographical research intensified after the Great Patriotic War. New resources had to be discovered and exploited in order to rehabilitate and further develop the Soviet Union's socialist economy. The country's growing international ties, particularly with the countries of People's Democracy, heightened interest in geographical literature. Soviet scientists began organising expeditionary research in the World Ocean.

There were a number of important organisational developments immediately after the war: in 1946 the Academy of Sciences' Oceanology Laboratory was transformed into the Institute of Oceanology; independent laboratories specialising in the study of aerial methods and of lakes were set up in Leningrad; in 1945 Institutes of Geography were established in the Academies of Sciences of the Azerbaijan and Georgian Soviet Socialist Republics. An increasing number of geographers graduated from the universities and teacher training colleges. The specialised State Geographical Publishers was organised; the geographical departments were strengthened in the Academy of Sciences' Publishing House and the Educational and Pedagogical Publishing House; geographical literature was produced by the publishing departments of such institutions as the Hydrometeorological Service and the Main Office of the Northern Sea Route.

The structure of Soviet geography gradually changed during this period: general physical geography which combined the whole system of physical geographical sciences, developed along with sectoral geographical disciplines; economic geography, on the contrary, began to concentrate more on sectoral specialisation. Geography was given a freer hand in resolving organisational and scientific problems. Economic geographers concentrated their research on the rehabilitation of the economy, especially in regions which had been under fire or close to the front. They also had to complete research projects suspended during the war and continue the theoretical and practical investigations. At the same time Soviet economic geography underwent both quantitative and qualitative transformations. In addition to the traditional fields

whose foundations had been laid in the pre-war period (the elaboration of general methodological problems of economic geography, ecogeographical studies of the USSR and other countries, the country's economic zonation, the geography of economic sectors, population and cities, economic cartography, etc.), entirely new branches and fields of geographical science were born (e.g., the geography of resources, the geography of infrastructure). Such new methods as quantitative research and systems analysis made their appearance. Economic geographers organised many more expeditions. There arose new educational and research institutions which produced highly-qualified personnel; an increasing part in economic geographical research was played by local bodies and their personnel, and by sectoral and design institutions. Methods of economic geographical research on foreign territories changed radically.

In the post-war years particular attention was given to natural historical zonation, the development of the theory of global processes and the publication of series of monographic descriptions of the country's nature.

Work on natural historical zonation was directed by a special commission to the Presidium of the Academy of Sciences, S. G. Strumilin and L. I. Prasolov were in overall charge, whilst I. P. Gerasimov, Y. M. Lavrenko, K. M. Markov and V. A. Troitsky directed the work of particular fields. In the pre-war period coordinated maps had been prepared of geomorphological, climatic, hydrological, soil, geobotanical and complex natural historical zonation. In 1947 the general work "Natural Historical Zonation of the USSR" by S. G. Strumilin, I. S. Lupinovich, S. Z. Zonn and two issues of the sectoral work—"Geomorphological Zonation of the USSR", and "Geobotanical Zonation of the USSR"—made their appearance, and the following year "Hydrological Zonation of the USSR" was published.

It is significant that these works made it possible to compile principally new zonation maps; their geomorphological zonation reflected the morphogenetic types of relief; in climatic zonation the accent was placed on climatic conditions of plant growth; geobotanical zonation emphasised the actual character of the vegetative cover. In general natural historical zonation the principal area in the system of taxonomic units was the natural region; this was followed by the zone, province, territory and district. Besides describing these

particular areas the books also gave an economic evaluation, primarily for the purposes of farming.

A. A. Grigoryev's monograph "Subarctic" of 1946 had a considerable influence on the development of the theory of general physical geography. As in previous short descriptions of the principal types of physical geographical environment, the author concentrated mainly on analysing the intensity of interrelated processes and typical matter and energy balances ranging from the inflow of solar radiation to biological productivity. "Subarctic" was the first geographical work to be awarded the USSR State Prize.

"The Fundamentals of General Earth Science" (1947) by S. V. Kalesnik helped establish the geographical envelope as the object of study of general physical geography. This was the first work to consider jointly the main geographical regularities of the geographical envelope (unity, zonal differentiation, the continuity of development, rhythmic, etc.) and indicate the areas of future search. The monograph confirmed the cognitive value of general earth science.

At the same time a number of sectoral geographical sciences, principally geomorphology, made considerable progress in elaborating new theoretical concepts. I. P. Gerasimov's "Experiment in Interpreting Geomorphologically the General Pattern of Geological Structure in the USSR" (1946) advanced new principles for classifying the relief of the earth and introduced the concepts of geotexture, morphostructure and morphosculpture.

In his "Fundamentals of Geomorphology" (1948), K. K. Markov turned his attention to extending the scope of geomorphology and stressed the need to study not just superficial, exogenous forms of relief, but large-scale tectonic forms. He introduced the concept of geomorphological levels arising in conditions of dynamic equilibrium between endogenous and exogenous forces. Like the research of B. L. Lichkov and V. G. Bondarchuk, these two fundamental works gave birth to structural geomorphology and drew attention to neotectonics, a term suggested by V. A. Obruchev in 1948.

In the field of climatology there was further convergence between the dynamic and synoptic areas. Research was aimed at regional features of circulation and its link with weather processes, and regularities in the recurrence of these processes and climatic fluctuations. These questions are

specifically considered in a work entitled "Typification of Circulation Mechanisms in the Northern Hemisphere and Description of Synoptic Seasons" (1946) by B. L. Dzerdzeevsky, V. M. Kurganskaya and Z.M. Vitvitskaya. L. A. Chubukov, developing the ideas of Y. Y. Fedorov, examines the relationship between local weather conditions and various air masses and circulation processes in his monograph "Complex Climatology" (1949).

As far as marine research was concerned mention should be made of two informative monographs—"Arctic Ice" (1944) by N. K. Zubov, which summarised the work of Soviet researchers in the Arctic, and particularly "Dynamic Oceanography" (1947) by the same author, which gave a theoretical summary of the development of oceanology over a period of about 15 years following the publication of Y. M. Shokalsky's "Physical Oceanography".

Of the works on the development of land hydrology and analysis of the laws governing the formation of runoff and its relationships with other elements of the geographical environment we should single out M. I. Lvovich's "Elements of the Water Regimes of the Earth's Rivers" (1945) and L. K. Davydov's "The Runoff Volume of USSR Rivers, Its Fluctuations and the Influence of Physical Geographical Factors on It" (1947).

In the field of geobotany V. B. Sochava examined the link between vegetation and climate-forming processes and dynamic types of climate in his work "Geographical Relationships of the Vegetative Cover in the USSR" (1948). In 1950 Y. M. Lavrenko proposed that the Palaearctic be divided into 10 botanical-geographical regions, including the intracontinental regions with clearly-defined latitudinal zonation of the vegetative cover, and the western and eastern oceanic regions showing "meridional zonation" of vegetation, which V. L. Komarov had noted in the twenties.

A. N. Formozov's monograph "The Snow Cover as a Factor of the Environment and Its Significance in the Life of Mammals and Birds" (1946) had a great influence on the development of the ecological trend in zoogeography. In 1947 G. V. Nikolsky made a comparative analysis of the biological specific features of fresh-water fish belonging to different natural complexes. The analysis showed that in the course of evolution similar adaptive features developed under specific conditions.

The examples quoted of works which pioneered new trends in the development of geographical sciences reflect one general tendency, namely the search for new laws at the junction of related geographical sciences and their consolidation within geography into three complex fields—geology and geomorphology, hydrometeorology and bioclimatology.

Landscape research also developed in the post-war years thanks to the initiative of geographers of Moscow and Leningrad Universities. The work of V. V. Dokuchaev, who laid the foundations of Soviet landscape science, was subsequently carried on by such geographers as L. S. Berg, B. B. Polynov, L. G. Ramensky. N. A. Solntsev, who developed the idea of landscape morphology and taxonomy and worked out field research methods for them, became one of the leading figures in landscape science at the time.

In the post-war years the production of regional descriptions of the USSR went hand in hand with the publication of monographs on foreign countries. It was decided to begin publication of descriptions of the country with the series "Nature of the USSR", since the economy of a number of regions had still to be rehabilitated. This series, which was aimed at the general reader, not only reflected features of nature, but showed their significance for the economy and the changes brought about by man.

In 1946 different publishers brought out three works in this series: "The North of the European Part of the USSR" by G. D. Rikhter, "The Northern Caucasus and the Lower Don" by S. V. Kalesnik, and "The Soviet Arctic" by a team of writers. By the end of 1953 some 13 books had been published in the series.

At the same time a popular science series appeared which dealt with the capitals of the Union Republics and the major cities of the USSR. This series, which consisted of contributions from various authors, covered such cities as Moscow, Leningrad, Kiev, Alma Ata, Ashkhabad, Baku, Yerevan, Dushanbe, Tbilisi, Voronezh, Perm, Sverdlovsk and many others. This period also saw the publication of a number of books in the popular science series "Our Land". Besides giving a colourful picture of the nature, population and way of life in the republics and regions of the USSR the series edited by the talented writer and geographer N. N. Mikhailov describes the Soviet economy and economic achievements. Among the works in this series are the books of N. N. Mi-

khailov—"The Russian Land" (1946), "At the Map of the Motherland" (1947), "Your Motherland" (1950) and a work on Kazakhstan "Arsenal-Republic" (1942), each of which appeared in a number of editions; the books of P. Luknitsky on Tajikistan (1947) and V. V. Pokshishevsky on the Volga region.

As far as the physical geography of foreign countries was concerned, original books based on field research began to appear at the time in addition to the works written from bibliographical sources. In 1948, for instance, E. M. Murzaev published a monograph entitled "The Mongolian People's Republic" for which he was awarded the USSR State Prize.

The Soviet methodology of regional studies, which was in the 1940s identified with regional geography, developed in this period. Two articles by N. N. Baransky—"Generalisation in Cartography and Geographical Textual Description" (1946) and "Regional Studies and Physical and Economic Geography"—were of fundamental importance in this area.

As before SOPS continued to organise multi-purpose expeditions to study new regions of development and determine natural resources. The complex survey of the land and water resources of Central Asia, the mineral resources of Turgai and Central Kazakhstan, the various resources of the Krasnoyarsk Territory, Tuva, the Baikal region, Yakutia and the Amur region was aimed at the long-term development of these areas. Research focussed mainly on the problem of how to develop the tremendous oil, gas and timber reserves of the West Siberian Plain; the hydroelectric power, timber and mineral resources of Northern and Central Kazakhstan; the land, water, fuel and hydroelectric power resources of the mountains and deserts of Northern Asia.

Expeditions now became of longer duration and drew their members from local scientific and educational establishments. Investigations made over definite routes gave way to surveys of particular areas, often using aerial photography. Stationary research was used to obtain not only qualitative, but also quantitative characteristics.

The first multi-purpose physical geographical station had been organised by the Institute of Geography of the Academy of Sciences just before the war. Work began on the study of heat and moisture balances at Zelenaya Sloboda in the

Moscow region. In 1947 the Institute set up a mountain physical geographical station in the Tien Shan range, which made observations of various natural processes. This station, which was handed over to the Kirghiz Academy of Sciences in 1953, continues to function to this day. Other leading geographical institutions organised complex physical geographic research at such stations.

After the country's first large research vessel *Vityaz* came into service in 1949, Soviet scientists began a study of the World Ocean.

Research in the Arctic also became more intensive and better planned at the time. In 1948 the first regular high-latitude aerial expeditions took place making vast areas of Arctic ice accessible for polar explorers.

By the end of the forties the study of individual aspects of nature had been virtually completed. This made it possible to begin compilation of reference maps on the nature and resources of the USSR: on its geological, tectonic (including the latest developments in tectonics), geomorphological, soil and geobotanical features.

Information on individual aspects of nature was also systematised in a number of major summaries and reference works which appeared in series of volumes. These included: "Geology of the USSR" ,"Tectonics of the USSR", "Hydrogeology of the USSR", "Distribution of Minerals in the USSR", "Regional Reference Books on the Climate of the USSR", "Soils of the USSR", "The Vegetative Cover of the USSR" and "The Animal World of the USSR".

By that time the whole territory of the Soviet Union had been surveyed from the air, studied topographically and charted in general geographical maps of various scales. Soviet geographers thus possessed comprehensive material from which they could produce a generalised description of the country's natural conditions and resources.

The development of Soviet geography was greatly influenced by the research which developed after the publication in October 1948 of the resolution "On the Plan for Field-Protective Afforestation, the Introduction of Grassland Crop Rotation, and the Construction of Ponds and Reservoirs to Guarantee Good, Steady Harvests in the Steppe and Forest-Steppe Regions of the European Part of the USSR", and a number of resolutions on the construction of major water works and power stations, canals and irrigation systems

on the Volga, the Don, the Dnieper and in Central Asia. This essentially involved drawing up plans for major development work over large areas of the country. To obtain the necessary scientific data for such plans intensive field research was organised involving geographers from the Academy of Sciences and other institutions, particularly universities. The work was coordinated by a special committee on construction projects set up under the Presidium of the Academy of Sciences. Major multi-purpose and specialised expeditions were organised.

The fundamentals of the theory involved in using land and forest amelioration in environmental development projects had been laid before the Revolution in the works of V. V. Dokuchaev, A. I. Voyeikov, P. A. Kostychev and A. A. Izmailsky. Research on these problems continued in Soviet times, but it was not yet the primary concern of geographers.

Meanwhile technical methods used in the interests of power engineering and navigation began to gain the upper hand in environmental development projects which were carried out by specially established technical organisations. The mission of forecasting the consequences of constructing large dams and reservoirs, exploiting water and forest resources as well as determining any environmental or ecological changes was successfully accomplished by the geographers who took part in the expeditions mentioned above.

By the early fifties the Soviet Union had completed the rehabilitation of its economy and surpassed the pre-war level of economic development. A new stage was reached in the construction of the developed socialist society during which man's influence on nature significantly increased. In addition to further industrialisation of the country, developing agricultural production and raising the standard of living of the working people, the Five-Year Plan of 1951-55 outlined a number of major economic tasks involving changes in the natural environment. These included: field-protective forest cultivation, land irrigation and drainage, erosion abatement aimed at achieving good, steady harvests; the construction of large-scale hydroelectric power complexes; work on regulating the major river flows in the European part of the USSR and developing a single water transport network which made Moscow a port of five seas. The development of the eastern regions of the country

continued: their minerals were exploited and large irrigation systems built in Central Asia and Transcaucasia. In 1953 and 1954 a project was started to develop for agricultural purposes vast areas of virgin and fallow lands in the Altai, Northern Kazakhstan and some other regions. All these major economic and environmental projects required a theoretical basis and scientific back-up. To this end specialised scientific and design institutions were set up within the Ministry of Geology; these included: Gidroproekt, Gidroenergoproekt, Giprogor, transport and land improvement services and the system of the Lenin All-Union Agricultural Academy (VASKhNIL).

Geographers took a most active part in elaborating the theoretical foundations for environmental development, in investigating and examining different projects and in popularising the ideas behind such development. The Institute of Geography of the USSR Academy of Sciences played an increasingly important role at the time as the main geographical institution.

Like soil scientists and geobotanists geographers became primarily concerned with finding new farmland and forecasting possible changes in its fertility. Maps with explanatory texts were compiled and published for the regions in which the Main Turkmen, Volga-Ural, Volga-Don, Lower Dnepropetrovsk and Northern Crimea canals were to be constructed. The results of research carried out by geographers, botanists, soil scientists and land reclamation specialists were synthesised in these works.

Work in various scientific fields was discussed at the Second Congress of the USSR Geographical Society (1955). In his report I. P. Gerasimov summarised the theoretical discussions and formulated the tasks for the future. He indicated that Soviet geography had not only accumulated a tremendous volume of factual material, but continued to develop the theory of the science and vitalise it with new ideas. The practical aspects of socialist construction had prompted Soviet geographers to tackle the most important and pressing theoretical problems and elaborate doctrines which would lay down new ways of using natural resources.

To further develop the theory and methodology of physical geography it was necessary to make wider use of accurate research methods. This involved not only cartography

and aerial photographic surveying, but accurate experimentation in stationary conditions so as to investigate the interconstituent relationships and the processes of matter and energy conversion.

By that time the Soviet Union had 200 actinometric stations (out of a total of 700 in the world) making observations of solar radiation and 40 stations measuring the thermal balance. Methods of measuring solar radiation developed by the Main Geographical Observatory made it possible to compile diagrams showing mean monthly and yearly values of global radiation and radiation balance. Heat losses from evaporation and the heat exchange with the atmosphere were taken account of in estimating the thermal balance of the earth's surface. There were many new materials that required theorisation. In 1954 the Presidium of the USSR Academy of Sciences gave top priority to the subject-matter entitled "Heat and Water Regimes of the Earth's Surface; Their Role in the Dynamics of Natural Processes and Methods of Using Them for Practical Purposes". The Institute of Geography under the USSR Academy of Sciences was commissioned to coordinate the work of Academy institutes, the Hydrometeorological Service and other establishments in this field.

The "Thermal Balance Atlas" (1955), compiled under M. I. Budyko at the Main Geophysical Observatory, was one of the first works to generalise various materials on this issue. Using newly-discovered regularities the authors gave a clearer idea of the genesis of climate and developed the theory of physical geography. In 1956 A. A. Grigoryev and M. I. Budyko formulated the "periodical law of geographical zonation" which explained the interrelationship between the conditions of the heat and water balance and geographical zones. This concept was used to develop a system of climatic classification of the USSR and climatic zonation maps. M. I. Budyko was awarded the Lenin Prize for his monograph "The Thermal Balance of the Earth's Surface" (1956).

Other scientists strove to determine the mechanism governing the heat and moisture relationship at the time: G. T. Selyaninov put forward a hydrothermal coefficient based on the correlation between the sum of active temperatures and total annual precipitation; N. N. Ivanov proposed a coefficient of moistening, i.e., the ratio of total precipitation to the estimated evaporability; S. P. Khromov developed the

concept of a coefficient of continentality linked with annual temperature amplitude. Climatic maps of the USSR and the world were compiled using these data and others elaborated by Y. S. Rubinshtein (1953), A. I. Kaigorodov (1955) and L. G. Polozova (1954).

The search for relationships between the more and more natural constituents boosted the development of methods of runoff calculation. M. I. Lvovich proposed a new method for analysing the water balance, which served as a basis for subsequent long-term studies. It was shown that runoff is influenced not only by the laws of nature, such as the circularity of processes, but also by man's activity, particularly methods of land cultivation.

In addition to irrigation and watering projects the plans for land development also covered forest amelioration. It was shown that forest belts of appropriate arrangement and composition not only protect farmland from dry winds, but also solve the problems of snow accumulation and retention of moisture, and even help prevent erosion. D. L. Armand, M. I. Lvovich and M. I. Budyko were among those who worked on the lay-out and location of forest belts.

Geographers were also concerned with the problems of the developed areas of the country. In 1952 the Academy's Institute of Geography and the Dokuchaev Soil Institute published a joint monograph entitled "On Improving Agricultural Land Use in the Non-Chernozem Zone of the European USSR". The authors put forward a wide range of measures, including liming of acid podzol soils, prevention of bogging, etc.

The study of individual resources was mainly continued by various branches of geographical science.

Geomorphological survey work, which assumed particularly great proportions in this period, was directed towards compiling a geological map of the country as one of the methods of studying its interior and alluvial deposits. Geomorphological maps provided a basis for the zonation of nature and the study of landscapes; geomorphology played a part in the selection of construction sites and transport routes.

In 1958 the Inter-Departmental Geomorphological Commission was set up to coordinate scientific and practical activity and develop unified methods of geomorphological surveying.

The fifties saw the first studies of modern tectonic movements of the earth's crust which were revealed in the course of repeated levellings. The first results of research carried out by the Academy's Institute of Geography and the Main Department were published in the joint monograph "Modern Vertical Movements of the Earth's Crust in the Western Part of the European USSR" (1958).

The results of the extensive research on the soil cover conducted by various scientific and industrial organisations were reflected in a number of review maps, such as the *Soil Map of the USSR*, which was compiled in 1954 by N. N. Rozov (with the assistance of Y. V. Lobova) and edited by I. P. Gerasimov. Using these maps Rozov estimated the country's land resources and the degree to which soils of various types could be developed for agriculture. Wide use was made of the soil maps in the cultivation of virgin and fallow lands. Using the principles of the Dokuchaev school of pedology a team of scientists under I. P. Gerasimov compiled the *Soil Map of the World* with a scale of 1:20,000,000.

Geobotanists continued to develop phytocenology—the study of plant communities, whose foundations were laid by V. N. Sukachev.

In 1956 the *Geobotanical Map of the USSR* edited by V. B. Sochava and Y. M. Lavrenko was published together with an explanatory text—the two-volume joint monograph "The Vegetative Cover of the USSR". In addition there appeared a map of the forests of the Soviet Union edited by F. M. Kozlov and V. P. Tseplyaev (1955), and a monograph entitled "Meadow and Pasture Management" (1956) by I. V. Larin.

In the early fifties zoogeographers undertook a study of the numbers of certain animal species, the specific features of their distribution and their confinement to various landscapes. They also continued the study of types of fauna and species habitation areas. The conferences which the Institute of Geography of the Academy of Sciences held regularly in conjunction with the Moscow Naturalists' Society from 1949 onwards helped organise the counting of animal populations and their dynamics as well as map their distribution.

There was a growing need for data not just on individual resources, but their combinations for the purposes of

planning and economic use. It became increasingly important to assess the exploitability of resources and work out rational methods of development and renewal.

To this end SOPS organised multi-purpose expeditions to the Krasnoyarsk region, Transbaikalia and the Far East.

The importance of geography increased with the development of new territories of the country; there was growing contact between physical and economic geographers in various practical organisations.

In this same period the Geography Faculty of Moscow University organised a number of multi-purpose expeditions by request of planning and design organisations. These included expeditions to the central chernozem zone (1947-51), Eastern Siberia (1948-54), the Ryazan (1954) and Zaraisk areas, Transcarpathia, the Caspian and Northern Kazakhstan regions. The parties included teachers and students from Moscow University and economic geographers from other organisations.

In the fifties and early sixties a team of economic geographers from the Academy's Institute of Geography produced a number of major works based on the findings of their own field research and extensive statistical and cartographic materials. The contacts and cooperation with local scientific, planning, design and other organisations greatly contributed to their preparation. The first of these were "The Komi-Permyak National Area" (1948), "The Urals" (1959) by I. V. Komar and "Kirghizia" (1946; second edition in 1951) by S. N. Ryazantsev, which was written according to a plan suggested by N. N. Baransky. The latter work became something of a standard for a subsequent series of economic geographic monographs on various regions of the Soviet Union. A team of economic geographers from the Institute of Geography acting in cooperation with their counterparts from other institutions—mainly subsidiaries of the USSR and Republican Academies of Sciences—produced the so-called Blue Series (because of its blue cover) on economic geography. These monographs give a comprehensive treatment of the natural conditions, resources, population, economy and development prospects of all the Union Republics of the USSR and the major economic regions of the Russian Federation, and their intrinsic differences. The Geographical State Publishers (Geografgiz) issued 27 books in this series.

Members of staff of other institutions, particularly university and college teachers, continued their work on general and individual aspects of economic geography. One can single out, for example, the following works: Y. G. Saushkin's monograph "Geographical Essays on Nature and the Agricultural Activity of the Population in Various Parts of the Soviet Union" (1947), which was actually the first detailed study of the interaction between nature and man's activity, and his textbooks on general economic geography (1955; second edition in 1958) and economic zonation (1966); V. A. Anuchin's evocative "Theoretical Problems of Geography" (1960); L. Y. Iofa's fundamental research on historical geography in his "Cities of the Urals"; R. M. Kabo's "Cities of Western Siberia" and V. V. Pokshishevsky's "Settlement of Siberia" (1951); various monographs on different sectors of the economy: "Industrial Geography of the USSR" (1955) by P. N. Stepanov, "Transport Geography of the USSR" (1960) by I. V. Nikolsky; works on the economic zonation of the country by P. M. Alampiev (1960) and N. N. Kolosovsky (1958); and V. G. Davidovich's "Settlement in Industrial Centres" (1960).

The structure of geographical institutions continued to improve and develop. Geographical bodies of various kinds, ranging from institutes to sections and groups, were set up in the majority of Republican Academies of Sciences and in some subsidiaries of the USSR Academy of Sciences. In 1955 and 1956 the Siberian Department of the USSR Academy of Sciences was set up to study the eastern regions of the Soviet Union. Among its associate establishments were the Institute of Geography of Siberia and the Far East (set up in 1959) in Irkutsk, the Institute of Permafrostology in Yakutsk, the Baikal Limnological Station in the village of Listvenichnoye which became an institute in 1966 and the Forest and Timber Institute in Krasnoyarsk. The Buryat, Sakhalin, North-Eastern (at Magadan) and Chita complex institutes, and the Institute of Volcanology in Petropavlovsk-Kamchatsky also did geographical research under the direction of the Siberian Department.

As has already been mentioned, the Soviet Union developed a ramified network of higher educational establishments with geography faculties or departments: as of January 1, 1959 some 30 universities and 62 teacher training institutes were involved in the teaching of geography. Apart

from traning geographers and working out curricula they organised regional research both in their own localities and in the areas where permanent expeditions, such as the Irkutsk and Astrakhan expeditions sponsored by Moscow University, were working. In order to give this research some direction and provide it with more efficient methods the Ministry of Higher Education following the initiative of geographers from Moscow University organised inter-university work on zonation for the benefit of agriculture. The Central Scientific and Methodological Bureau was set up in 1956 under N. A. Gozdetsky to direct this work, the first results of which were published in the sixties.

Soviet geographers considerably expanded their international ties in the fifties. In 1955 the USSR Academy of Sciences became a member of the International Geographical Union, and two years later the National Committee of Soviet Geographers was established under the chairmanship of Academician I. P. Gerasimov. Since 1956, when the 28th Congress of the International Geographical Union* was held, Soviet scientists have regularly participated in the work of the Union's congresses and its standing committees and sections.

This period is characterised by an intensive study of the geography of foreign countries. The *Atlas of the World*", a major Soviet reference work published in 1954, set out the results of topographical studies of the USSR and collated data of a similar kind on the world as a whole. The atlas, which listed over 205,000 geographical names in its index, depicted in a much improved fashion the relief of the land and the sea-bed thanks to the successful methods developed by Soviet geographers and cartographers. I. P. Zarutskaya and V. P. Zenkovich were awarded the USSR State Prize for their altimetric map of the Soviet Union.

Soviet participation in the work of the International Geophysical Year (1957-59) proved important for the development of the country's geography. The IGY's field work went on for a period of 914 days, but preparations were started long before the official opening date. Systematic observations were made in the Soviet Union for each of the 14 basic aspects of the Programme. Of particular significance

* Before the Soviet Union joined the International Geographical Union, Soviet geographers attended the 13th Congress in Paris (1931) and the 14th Congress in Warsaw (1934).

were the glaciological and oceanological studies, which required new research bodies and personnel. Their findings brought about drastic changes in the nature of these sciences.

In 1947 the whaling flotilla *Slava* resumed the exploration of Antarctica which had been started by its discoverers, F. F. Bellinsgauzen and M. P. Lazarev. Eight years later a Soviet multi-purpose expedition went to the Antarctic in the diesel-electric ships *Ob* and *Lena*. Soviet scientists have been studying the South Polar regions continuously since the first Soviet Antarctic Station *Mirny* was set up in 1955.

A sound theoretical basis had been laid by Soviet scientists for glaciological research during the IGY Programme. In 1955 N. A. Shumsky published a monograph entitled "Principles of Structural Glaciology", which led to the formation of a new branch of the science. The works of G. A. Avsyuk (1956) on the temperature conditions of glaciers and M. V. Tronov (1954, 1956) on mountain glaciology and the relationship between glaciation and climate were also of great significance.

A department of glaciology was established at the Institute of Geography to organise preparations for the IGY. Soviet scientists carried out glaciological research at six stations in Antarctica and 11 stations in the USSR during the IGY. Systematic observations were made simultaneously in all the country's glacial regions. Wide use was made of modern electrometry methods of measuring the main parameters of the ice, drilling, observations of the speed of glacier movement, ablation, etc. This work, which was carried out by the USSR Academy's Institutes of Geography and Permafrostology, various institutions of the Academies of Kazakhstan, Kirghizia and Uzbekistan as well as by Moscow, Leningrad and Tomsk Universities, began a new era in Soviet glaciology.

Soviet science has great traditions in the study of the seas and oceans. The *Atlas of the Sea*, which was compiled by numerous teams of Soviet scientists, collated the most important data on the World Ocean accumulated up to the early fifties. The first volume of the atlas (1950) contained physical geographical maps of the seas and oceans and a description of the continents; second volume (1953) dealt with the oceanography of the World Ocean and individual seas and oceans; the history of the navy was the theme of the third volume, published in 1957.

Oceanology, a science dealing with the interrelated and interdependent physical, chemical and biological processes taking place in the seas and oceans, continued to evolve during the fifties in the Soviet Union, where it was first developed.

The early fifties saw an increase in the size of the fleet of specialised vessels: after the *Vityaz* came the *Mikhail Lomonosov*, the *Ob* and the *Lena*. Equipment became more sophisticated: Soviet designers developed among other things special tubes for taking samples of the sea-bed, various optical instruments, devices for measuring currents, thermographs and thermosondes. The drifting stations of the *Severny polyus* (North Pole) series, which have operated continuously since 1954, and the temporary stations, where scientists were taken in a specially equipped aircraft to make observations for short periods, were used in studying the Arctic region.

According to Y. Y. Gakkel's monograph "Science and the Conquest of the Arctic" (1957), the research of the fifties has drastically changed our conceptions of the Arctic Ocean, its relief and geological structure (the ridges discovered were named after Lomonosov and Mendeleyev), its geophysical and oceanological features, the movement of the ice and the meteorological processes in the Arctic. New material was gathered on the Atlantic and Pacific Oceans, particular attention being given to the Bering Sea and the Sea of Okhotsk. A study was made of the deep Kuril Depression and the complex relief of the sea-bed in the surrounding regions of the Pacific Ocean. Interesting results were obtained from work on the water exchange between the oceans and the theory of ocean currents (V. B. Shtokman, 1948, and others; P. P. Zubov, 1956).

Marine biology developed successfully in this period; here we should mention in particular L. A. Zenkevich's two-volume work "The Fauna and Biological Productivity of the Sea."

Considerable progress in the development of field research, the production of major generalised works in practically all branches of science, the strengthening of ties between them and the emergence of interdisciplinary fields paved the way for further developments in general physical geography, comprising earth science and landscape science. The rate of development in these fields varied throughout the fifties, however.

As far as general earth science was concerned, new discoveries related mainly to the laws of historical development of the geographical envelope. K. K. Markov's "Paleogeography" (1951) gave a general review of these laws and described how the earth's surface formed in the course of geological history. A. V. Shnitnikov's "Changeability of the Total Moistening of the Continents in the Northern Hemisphere" (1957) considered the cyclic nature of climate fluctuations and related changes in the levels of lakes and the conditions of glaciers.

The works of A. G. Isachenko (1953), I. M. Zabelin (1957 and 1959) and F. N. Milkov (1959) were of a less specialised nature. The second edition of "The Fundamentals of General Earth Science" (1955) and "A Short Course in General Earth Science" (1957) by S. V. Kalesnik provided a basis for general earth science as a branch of physical geography concerned with the geographical (landscape) envelope of the earth.

Landscape science developed at a particularly rapid rate in the fifties. Major field research projects were undertaken by Moscow, Leningrad, Voronezh, Lvov and some other universities. Geographers from almost every higher educational establishment carried out landscape surveys; some universities organised special landscape laboratories and expeditions. The Geographical Society's regular conferences on landscape studies, which began in 1955, did a great deal to promote this work and improve the methods used. These conferences and conference papers considered the theory and methodology of landscape science in which typological, geochemical and other trends developed alongside the morphological trend of the Moscow University school of landscape geographers. In 1955 there appeared "Essays on Landscape Geochemistry" by A. I. Perelman who, like B. B. Polynov before him, laid great stress on the migration of matter.

Progress in topical geography stimulated the development of regional geography. In the mid-fifties the Academy's Institute of Geography undertook the publication of "Physical Geography of the USSR", a basic geographical work in 12 volumes. The new series was conceived as a summary of the knowledge accumulated both by general physical geographers and topical geographers. Only three volumes were published in the series: "Steppes and Forest-Steppes of the Russian Plain" (1956), "Central Asia" (1958) and "The Far East" (1961). These works dealt principally with scientific questions and

considered only superficially the economic aspects of nature and its components. It was therefore decided to change the type of publications to meet practical needs, particularly those of planning and design organisations.

The Institute of Geography of the USSR Academy of Sciences and a number of other institutions and educational establishments continued to study the geography of foreign countries (primarily of the socialist ones), their groups and individual regions, and prepare monographs on their physical and economic geography. The first post-war monographs of this kind were compiled from bibliographical sources. These included: "Great Britain" (1947) by I. A. Vitver; "Bulgaria" (1949) by E. B. Valev; "Africa" (1953) by A. S. Barlov; "Chile" (1952) by A. A. Dolinin; "North-East China" (1955) by E. M. Murzaev; "Czechoslovakia" (1954) by I. M. Mayergoiz; "Sweden" (1954) by E. D. Zhibitskaya; and "Burma" (1958) by A. A. Tolokonnikova. Subsequent development of international contacts enabled Soviet geographers to draw from their own experience of travel in foreign countries. I. P. Gerasimov's "Essays on the Physical Geography of Foreign Countries" (1959) and M. B. Gornung's "Algeria" which was the first in a series on the nature of the African countries belong in this category.

Dozens of general geographical and economic geographical monographs on various countries of the world were written in the fifties and early sixties under the guidance of K. M. Popov at the Institute of Geography. These included: extensive works on the United States of America (the three-volume "Economic Regions of the USA" by M. Y. Polovitskaya, V. M. Andreeva, V. M. Gokhman and V. P. Kovalevsky, 1956-58); six monographs on India and Pakistan (L. A. Knyazhinskaya, O. B. Oskolkova, G. V. Sdasyuk, V. A. Pulyarkin, et al., 1956-62); books on Indonesia (V. I. Antipova, 1961), Mexico (Y. G. Mashbits, 1961), Germany (M. M. Zhirmunsky, et al., 1959), Great Britain (A. S. Dobrov, 1955), and Italy (G. D. Kulagin, 1954).

The staffs of Moscow University and some other institutions also produced book series and individual monographs on the economic and political geography of foreign countries at this time. We can place in this category the major summary work "Introduction to the Economic Geography of Foreign Countries from the Standpoint of Historical Geography" (1963) by I. A. Vitver; V. T. Zaichikov's "Korea"

(1947, 1951); "France" (1958) by I. A. Vitver and A. Y. Sluka; Y. D. Dmitrievsky's "Sudan" (1959); and M. S. Rozin's "Geography of Africa's Minerals" (1957).

Ethnography, which is very close to economic geography, and particularly to population geography, underwent rapid "geographisation". Economic geographical aspects were increasingly prominent in the works of both general and regional ethnographers; distribution of the different peoples inhabiting the USSR and foreign countries and specific features of their economies came more and more to the fore. From isolated historico-ethnographic research such as that covered in S. I. Rudenko's book "The Bashkirs" (1955) or L. P. Potapov's "Peoples of Southern Siberia" (1953) ethnographers moved to complete ethnographic surveys of the Soviet Union and foreign countries. The staff of the Academy of Sciences' Institute of Ethnography produced a fundamental series entitled "Peoples of the World" (its latter volumes were published after 1963). This included: works on the USSR—"Peoples of Siberia" (1956), "Peoples of the Caucasus" (Vols. 1-2, 1960-62), "Peoples of Central Asia and Kazakhstan" (Vols. 1-2, 1962-63) and a summary volume "Peoples of the USSR" (1958); works on foreign countries—"Peoples of Africa" (1954), "Peoples of Australia and Oceania" (1956), "Peoples of Western Asia" (1957), "Peoples of America" (Vols. 1-2, 1959-60) and "Peoples of Southern Asia" (1963); a monumental reference work summarising this ethnographic research "The Numbers and Distribution of the Peoples of the World" (1962), edited by S. I. Bruk and later the "Atlas of the Peoples of the World".

In 1959 the USSR Geographical Society held its third congress in Kiev. Here, in addition to papers on the general theory and practical application of landscape science, the temperature and water conditions of the earth's surface and economic geographical zonation, attention was focussed on the role of geography in the study, use, preservation and renewal of the country's natural resources. This issue, which involves both theoretical and practical aspects, became extremely prominent in Soviet geography in subsequent years.

The monograph "Soviet Geography. Achievements and Tasks" (1960) gave a comprehensive account of the state of geography in the USSR and described the main advances in geographical theory up to the end of the fifties and the tasks

for the future. This book, which was published on behalf of the USSR Geographical Society, examined the work done and outlined the prospects for future development. This was dictated both by the need to plan the current and future development of the economy and by the major reorganisation of traditional geographical research methods resulting from progress in geophysics and geochemistry. Publication of this book was timed for the 20th Congress of the International Geographical Union.

GEOGRAPHY IN THE SIXTIES AND EARLY SEVENTIES

When a major programme was drawn up in the early sixties for building the material and technical basis of communism, the short-term and long-term planning of the economy assumed even greater importance than before. This programme envisaged the intensive and extensive development of various natural resources taking account of local conditions, both natural and economic; it also envisaged rational distribution of industrial enterprises and transformation of natural features of large regions in the interests of the economy. At the same time it had to be borne in mind that the growth in production which went hand in hand with scientific and technological progress brought with it the problems of protecting nature and using its resources in the most rational way. Man's pressure on nature is becoming so universal and intensive and causing such tremendous changes in the world that the environmental problem, that is maintenance of the right conditions for human existence, may be regarded as one of the most urgent problems facing mankind.

Soviet geography has an important part to play in tackling these major problems which can only be solved with the concerted efforts of representatives of natural, social and technical sciences. The level of development of geography, its wealth of experience and qualified personnel, accumulated knowledge and ability to adopt rapidly the new methods of research afforded by technological progress help to raise its status as a science, and enable it to accomplish the mission entrusted to it.

The rapid expansion of geographical institutions in this period therefore brought with it a strengthening of contacts between geographers: a large number of joint summary works, both on the Soviet Union and the world as a whole, made their appearance; new geographical stations were set up and more accurate research methods introduced. Increasing use was made of data on the balance of living matter (in addition to data on the hydro-climatic aspect of nature) when considering the matter and energy balance in natural processes. Biological productivity was used as one of the criteria for assessing natural complexes and making changes in them.

Geographers considerably expanded their ties with representatives of natural, social and technical sciences. In particular they established contacts with specialists in the fields of economic geology, sociology, ethnography, demography, medical geography, architecture and civil engineering. The new contiguous sciences developed rapidly in this period; they included: geochemistry, geophysics, biogeophysics, the economic geographical study of resources (the geography and methodology of assessing natural resources and the natural living conditions of the population), geographical urbanisation, the geography of the infrastructure and compilation of topical maps. Physical and economic branches of geography drew closer together, a fact which was reflected not only in the production of joint publications, but in the creation of new, essentially contiguous disciplines such as medical geography and recreational geography.

New forms of cooperation between Soviet geographers and their foreign counterparts began to take shape. Apart from participating in international forums and joint programmes involving information exchange and closer personal contacts they cooperate directly with foreign geographers, particularly those of the socialist countries, in carrying out joint geographic research.

The search for new resources and the survey of newly-developed lands remained a most important aspect of geographical science. The transfer of SOPS from the Academy of Sciences to Gosplan in 1960 and the development of local geographical institutions, principally in the Union Republics, increased the role of geographers in studying the nature of the country in its entirety.

The early sixties saw the continuing publication of works bringing together the results of SOPS expeditions, particularly its special multi-purpose expedition to the newly-developed lands. Geographers put forward some wide-ranging ideas on the use of these territories. The monograph "Natural Zonation of Northern Kazakhstan" (1960), for example, was based on the research of the Kazakhstan group of this expedition in the virgin lands. This work not only described the natural features of the region, but attempted to assess the changes brought about by wide-scale cultivation of the virgin lands and outline rational ways of using them in the future for agricultural purposes.

The findings of the many years of research (directed by V. S. Preobrazhensky) on the nature of Transbaikalia, which was aimed at developing agriculture and determining the conditions for exploiting the Udokan copper deposit, were brought together in a number of joint and individual monographs published by the Institute of Geography between 1959 and 1965. These works put forward proposals on the use of various regions of the mining and metallurgical industry, agriculture and communications, and stressed the importance of hollows in the economic development of mountain-taiga regions.

The sixties saw the completion of the Blue Series of economic geographical descriptions of all the Union Republics and the major economic regions of the Russian Federation. The joint monograph "Geographical Development Problems of the Major Economic Regions of the USSR" was the final work in the Blue Series.

Monographs and even series of monographs on regional economic geography compiled by scientists from other Academy institutions and higher educational establishments were published both centrally and in the republics. These included economic geographical series on the Ukraine, Kazakhstan and Byelorussia. The main accent in these works shifted towards the regional organisation of productive forces.

In the meantime atlas cartography was also making considerable progress. Academic and scientific cartographical institutions compiled a series of interrelated scientific reference maps of the Soviet Union and collated in complex and specialised atlases data on the country's nature, resources, population, economy and culture. Such, for example, were the "Atlas of Soviet Agriculture" (1960), edited by M. I. Ni-

kishov, and the "Atlas of Soviet Economic and Cultural Development" (1967). The atlases of individual Union Republics and regions of the Russian Federation, which appeared at the time, included the "Atlas of the Armenian SSR" (1961), "Atlas of the Irkutsk Region" (1962) and "Atlas of the Kustanai Region" (1963). In addition there appeared the "Atlas of Transbaikalia" (1964) with a special large section of medico-geographical maps, and the "Atlas of the Karaganda Region" (1969) with a special map entitled "Assessment of the Population's Natural Living Conditions".

The joint monograph "The Natural Resources of the Soviet Union, Their Use and Renewal" (1963) was the first attempt to give a comprehensive description of the country's natural resources (excluding mineral resources) in their totality. Besides providing a quantitative and qualitative account of the resources of land, water, vegetation and animal life and their regional distribution the authors gave a comparative assessment of the reserves in the Soviet Union and other countries. The book also made certain recommendations on the rational use, protection and renewal of natural resources. This approach was adopted and developed in other works, especially those on individual regions. Particular mention should be made of research on the use of the resources of Lake Baikal and the Baikal region, the results of which formed the basis for measures on the preservation of the unique features of the Lake Baikal waters. The publication of the monographs "Problems of the Economic Development of the Volga-Akhtubinsk Floodplain and the Volga Delta" (1962) and "Problems of Environmental Development in Central Asia" (1960) marked the completion of important research work in these regions.

At the time republican and regional institutions and universities began compiling atlases on the natural conditions and resources of their territories.

Apart from describing individual areas and resolving regional problems it was necessary to provide a fuller account of the country as a whole. To this end a series of monographs entitled "The Natural Conditions and Resources of the USSR" was compiled. Unlike the topical accounts on individual aspects of nature and the resources associated with them the series was aimed at giving some idea of the whole natural complex and the regional combinations of resources. This information was designed for national and republican

planning organisations. The series was, however, an academic summary in the true sense of the word, i.e., a collation of the various studies of the country's geography. "Western Siberia", the first volume in the series, appeared in 1963.

The increasing authority of geography, its practical orientation and growing links with other sciences were demonstrated at the Fourth Congress of the USSR Geographical Society in 1964. The joint report of L. P. Gerasimov and S. V. Kalesnik traced the evolution of the very content of geography, which transformed from a passive and cognitive science investigating and describing little-known territories into an active force assisting man in the use of resources and the organisation of economic activity in populated regions.

A special report made by K. A. Salishchev on behalf of the National Committee of Soviet Geographers and the speeches of the numerous foreign guests emphasised the strengthening of Soviet geographers' international ties.

The congress heard reports on the preparation of a number of geographical series, including the Academy's "Natural Conditions and Resources of the USSR"; "The Zonation of Soviet Territory for the Purposes of Agriculture", undertaken by a number of higher educational institutions; and the popular "Soviet Union" by "Mysl" Publishers. The first volumes in these series were approved by the congress.

The general progress made by geographical sciences in the sixties was greatly promoted by joint ventures undertaken by geographers, particularly by the preparation of the *World Atlas of Physical Geography* and various series describing the country's geography. These works not only summarised what had already been learnt, but helped formulate the general tasks and methods, and iron out the disproportions between sciences.

The works of Y. A. Meshcheryakov on the geomorphology of the plain and platform regions (1960) and the flat countries (1965) further developed I. P. Gerasimov's ideas on the morphostructure of our planet. The entire planet was made the subject of a morphostructural analysis which took the form of a series of geomorphological maps of all the continents and ocean beds. These maps were published as part of the *World Atlas of Physical Geography* (1964) and later appeared in a summary work entitled "The Relief of the Earth. Morphostructure and Morphosculpture."

The results of research on the dynamics of relief using physical and mathematical methods based on the quantitative description of relief formation and fixation of its dynamics were summarised in maps of contemporary movements of the European USSR (edited by Y. A. Meshcheryakov) and Eastern Europe (edited by D. A. Lilienberg, 1973).

Geomorphologists began to make wider use of comparisons between processes in mountain glaciers and the Antarctic (A. A. Aseyev) when reconstructing the relief of regions of ancient glaciations. K. K. Markov, A. A. Velichko and G. A. Lazukov produced a three-volume paleogeographical summary of the Ice Age over the territory of the USSR. Paleogeographers strengthened their links with anthropologists and archeologists. A number of works dealt with the influence of natural changes on the development of primitive society (A. A. Velichko, 1970).

There were continued improvements during this period in the theory and methods of forecasting atmospheric processes; automatic systems were employed and the scope of forecasting was increased to include new subjects. This was the first of the sciences of the earth to use data from satellites and other automatic observation stations and process the resulting information on computers.

Research on climate-forming processes and the general circulation concentrated on the influence of the overlying surface and the interaction between the atmosphere and the ocean. By making use of the weather ships *A. I. Voyeikov, Y. M. Shokalsky* and others Soviet scientists were able to extend their range of research and send up rockets and radiosondes over a wide area of the World Ocean.

Special attention was given to climatic changes in cities. Research continued on fluctuations of climate and the relationship between atmospheric processes and solar activity.

Significant results were obtained in the field of applied climatology, particularly in agricultural climatology, and in developing methods of controlling the weather. Work on air pollution was carried out under F. F. Davitaya. In 1972 M. I. Budyko published a summary work entitled "Climate and Life".

In 1962 Soviet glaciologists turned over to the International Data Bank 137 volumes of analysed data obtained during the IGY. Apart from a number of monographs on regions of contemporary glaciation in the USSR (Kodar,

Novaya Zemlya, the Polar Urals, Suktar Khayata, the Zailiiskoye Alatau, etc.) the works include summary monographs such as V. M. Kotlyakov's "The Snow Cover of Antarctica and Its Role in the Contemporary Glaciation of the Continent" (1961), S. V. Kalesnik's "Essays on Glaciology" (1962) and T. K. Tushinsky's "Glaciers, Snowfields and Avalanches in the Soviet Union" (1963).

Systematic observations of glacial fluctuations began in 1964 as part of a twenty-year international programme. A good deal of work was done on compiling a catalogue of glaciers in the USSR, developing the theory of glaciation and studying the role of glaciation in the development of the earth.

Research continued on the snow cover and its influence on the processes occurring in the geographical envelope. A new discipline concerned with the study of snow landscapes made its appearance.

Soviet scientists have now been making a planned study of the Antarctic for some twenty years. Some fifteen scientific observatories and stations equipped with snowmobiles and airplanes have been set up there during this period. Two-fifths of the Antarctica coastal strip have been charted with the aid of aerial photography. Major geographical discoveries made both on the continent itself and in the surrounding waters include the extensive Sovietskoye Plateau, the IGY Valley, and sub-glacial mountain ridges and plains. Current ideas on the nature of the Antarctic are summarised in the two-volume *Atlas of the Antarctic* (1966-69), the first comprehensive work on the geography of that region. The atlas was awarded the State Prize of the USSR.

The *World Atlas of Physical Geography* offered perhaps the widest selection of maps dealing with the earth's water; it described all aspects of the hydrosphere and the various methods used to study them. The problem of supplying sufficient fresh water for man's needs became the focal point in the study of the hydrology of the land.

M. I. Lvovich gave a comprehensive analysis of the principal water users and their interaction with sources of water (particularly the influence of agricultural amelioration on water runoff) in his monograph "Man and Water. The Transformation of the Water Balance" (1963).

A team of hydrologists from the Academy's Institute of Geography estimated the balance of water resources of the

USSR (1967, 1969); results of research on the continents completed in this period were summarised by M. I. Lvovich in his "World Water Resources and Their Future" (1974). A team of experts from the Gidroproekt estimated the hydropower resources of the USSR (1967) and analysed the role of water engineering in the complex use of the country's water resources (1970).

A. M. Alpatyev probed man's influence on the earth's water cycle (1969), whilst G. P. Kalinin summarised the total effect of this influence in his monograph "Problems of Global Hydrology" (1968). A large number of works appeared on the hydrology of the country's largest regions, on the artificial redistribution of water runoff, large-scale water works and their effect on runoff (S. L. Vendrov, 1970 and others), and on individual hydrological installations throughout the Soviet Union; the latter included works on rivers (P. S. Kuzin, 1960; M. I. Lvovich, 1971), lakes (a number of collections by limnologists of the Academy's Institute of Geography edited by L. L. Rossolimo) and water reservoirs (A. B. Avakyan, V. A. Sharapov, 1968). In 1968 the Institute for the Study of Water Problems was set up under the USSR Academy of Sciences; in 1971 the Limnology Laboratory in Leningrad was transformed into the Institute of Limnology. The following year the journal *Water Resources* appeared for the first time.

Work on compiling large-scale soil maps was given a boost in 1962 with the establishment of special Giprozem institutes in all the Union Republics.

In order to make more effective use of agricultural land general principles were formulated for dividing the USSR into different soil zones; scientists drew up a soil zonation plan of the USSR ("Geographical Zonation According to Soil Types", 1962) and more detailed zonation plans of each of the republics.

Biogeographers prepared original maps describing the flora and fauna of the earth for the *World Atlas of Physical Geography*. Progress was made in the science of biocenology, particularly in the classification of biogeocenoses ("Principles of Forest Biocenology", edited by V. N. Sukachev, 1964).

Researchers began to concentrate more on investigating the productivity of biocenoses and the accumulation of organic matter in them. Mention should be made of a num-

ber of works written jointly by N. I. Bazilevich and L. Y. Rodin (1965) and others which set out to estimate the total phytoproductivity both on the land, and in the biosphere as a whole, and describe in quantitative terms the biological cycle of matter.

In zoogeography work went ahead on calculating the populations of various animal species, and studying the character of their habitation areas.

Recently a biocenological trend has also started to take shape in zoogeography due to the combined efforts of biogeographers from the Academy's Institute of Geography, Moscow University and the Institute of Plant and Animal Ecology within the Urals subsidiary of the USSR Academy of Sciences. Its proponents regard the animal population as a mobile system in which various functional, trophic groups may be distinguished. Scientists are trying to assess their biomass and the mean value of their activity, and determine the movements of matter and energy in different ecosystems.

Oceanologists have also been involved in joint geographic research. Maps and charts of the oceans appear in the *World Atlas of Physical Geography*, in complex atlases of the Antarctic and in a number of collective monographs. At the same time, because of the continuing differentiation of science, the widening scope and growing complexity of research and the development of special methods oceanology itself has developed into a compound system of sciences comprising physical, chemical, geological and geomorphological, biological, economic and applied disciplines. Soviet oceanologists have at their disposal a large fleet of vessels for field research, a broad network of scientific institutions, stations, etc., within Academy establishments, the Hydrometeorological Service, the Ministry of Fisheries, the Navy, and so on. The leading scientific body in this field is the complex Institute of Oceanology of the USSR Academy of Sciences.

Of the major summary works on oceanology one should single out the books of O. A. Alekin (1956) and A. P. Vinogradov (1967) on the geochemistry of the ocean, those of L. A. Zenkevich (1963) and T. S. Rass (1965) on the biology and fish resources of the seas in and around the USSR, and those of O. K. Leontyev (1961) and V. P. Zenkovich (1962) on the geomorphology and dynamics of coasts. Zenkovich was awarded the Lenin Prize for his monograph "Fundamental

Concepts of Coastal Development". Monographs were published containing a comprehensive description of the oceans and the fish resources of the coastal seas.

Evidence of the growing contacts between geographers studying the land and oceans was clearly seen at the Fifth Congress of the USSR Geographical Society in 1970 when a number of reports were presented on the study of the shelf zones of the ocean and the role of the sea in global processes. The interdepartmental Commission on the Geography of the Ocean was set up under the auspices of the Oceanological Commission of the USSR Academy of Sciences.

The sixties saw the successful development of general physical geography, an independent discipline, which is primarily concerned with studying the geographical envelope (the landscape sphere) of the earth and the natural geosystems (geographical landscapes or natural-territorial complexes) that comprise it. It is an imprescriptible methodological principle of the Soviet school of physical geography that geosystems exist objectively. The development of physical geography in the USSR has been promoted by the growing need for a multiple approach to the solution of such territorial problems as economic development of new regions, the rational use of resources and the protection of nature and environmental development. Physical geography is broadening its contacts with architectural and planning sectors, public health, economic and medical geography, and the geography of population.

S. V. Kalesnik's "General Geographical Laws of the Earth" (1972) helped develop further the idea of the unity and integrity of the geographical envelope. Y. M. Ryabchikov studied the structure and dynamics of the geographical envelope and the changes in it caused by man (1972). Interest grew in the relationship between the geographical envelope and cosmic phenomena (M. M. Yermolaev, 1967) and attempts were made to find analogues of it on other planets (I. M. Zabelina, 1970). K. K. Markov and G. D. Rikhter made an attempt to unify the study of the land and the ocean.

The boundary discipline between earth science and landscape science dealing with the differentiation of physical geography and serving as a scientific foundation for natural zonation continued to take shape. The problem of zonation and azonal factors of differentiation continued to predominate in this field. A whole series of works dealt with the

theory and methods of physico-geographical zonation (A. G. Isachenko, 1965; F. N. Milkov, 1966, 1968, 1970; V. I. Prokaev, 1967; N. I. Mikhailov, 1960-63, 1967). V. S. Preobrazhensky (1966) and others developed the idea of dialectical unity between the discreteness and continuity of geographical space and advanced the concept of two models of natural complexes—monosystematic and polysystematic. Landscape science benefitted from new ideas on the geographical complex as a self-regulating informational system.

In the sixties the geochemistry of landscapes developed as a special branch of landscape science (A. I. Perelman, 1966; M. A. Glazovskaya, 1964 and others). The geophysical trend, involving the study of the thermal balance, the moisture cycle and the associated problems of the biological productivity of landscapes, also took shape at the time. Experimental research in this area has been carried out at the Kursk Station of the Academy's Institute of Geography (see "Landscape Geophysics", 1967 and 1970).

Another rapidly developing field is satellite geography, that is the study of the earth from satellites, which can encompass vast territories and follow the dynamics of global processes by using remote-controlled methods of observation. Such methods are already in general use for weather forecasting, and determining geological structures. They are also employed in the study of natural resources. Soviet and American scientists are currently cooperating in research from satellites.

V. B. Sochava (1967) and other members of staff of the Institute of Geography of Siberia and the Far East have continued to develop the structural and dynamic trend in the study of geosystems, making wide use of the data obtained by the Institute's stations.

V. S. Preobrazhensky has summarised the different methods used in landscape research (1968).

Physical geographers have during this period compiled landscape maps of varying scales. These include a review map of the USSR prepared at Leningrad University under A. G. Isachenko, a map showing the natural zonation of the continents compiled at Moscow University under Y. N. Lukashova and A. M. Ryabchikov for the *World Atlas of Physical Geography* (1964), and many general and regional plans on the natural zonation of the USSR. Economic geographers have continued to develop the general theory

of their science, laying particular emphasis on the economic zonation and formation of industrial-territorial complexes.

Various aspects of these problems are dealt with in the following works: the monograph "The Efficiency of Complex Development of Economic Regions" by E. B. Alaev (1965); the collections entitled "Laws and Factors in the Development of the USSR's Economic Regions", edited by Y. G. Feigin (1965) and "Laws Governing the Formation of Industrial-Territorial Complexes" (1968); a book containing the selected works of N. N. Kolosovsky "Theory of Economic Zonation" (1969); the monographs "Theory and Methods of Economic Zonation" (1967) by A. M. Kolotievsky, "Complex Development of the Soviet Economy" (1966) and "Economic Geography—History, Theory, Methods, Practice" (1973) by Y. G. Saushkin and "The Theory of Economic Geography" (1964) by B. N. Semevsky. The geography of population, cities and development areas was the subject of the following monographs: "Constructive Geography of Regions. Fundamentals of Regional Planning" by D. I. Bogorad; "Town and Regional Planning. Engineering and Economic Principles" (1964) by V. G. Davidovich: "The Population of Georgia. An Economic Geographical Study" (1968) by V. S. Dzhaoshvili; "The Geography of Cities and the Fundamentals of Town-Building" (1969) by G. M. Lappo; "Fundamentals of Regional Planning" (1971) by Y. N. Pertsik; "Geography of the Population of the USSR" and "Geography of the Population of Foreign Countries. Economic Geographical Essays" (1971) by V. V. Pokshishevsky; "Urban Settlement in the USSR (Problems of Growth and Their Study)"; "Essays on the Geography of Distribution of Population" (1968) by B. S. Khorev; and the collections "Geography of Population and Human Settlements" (1967), and "Marxist-Leninist Theory of Population" (1971) edited by D. I. Valentei.

A number of works written in this period analyse the distribution pattern of Soviet industry, agriculture and transport. These include the following monographs: "Geography of the Soviet Timber Industry" (1966) by V. L. Gorovoi and V. A. Privalovskaya; "Agrogeography (Analysis of Local Conditions and the Territorial Organisation of Agricultural Production" (1967) by K. I. Ivanov; "The Distribution of Socialist Industry" (1971) by A. Y. Probst; "Geography of Soviet Industry" (1969) by A. T. Khrushchov; "Industrial Regions and Centres of the USSR" (1972); and a collection

entitled "Transport and Economic Communication in the USSR" (1965).

In the field of economic geography new, accurate methods were outlined in V. P. Shotsky's "Cartographical Research Methods in Agricultural Geography" (1970) and in a series of works on the application of mathematical methods; these included: "Mathematical and Geographical Methods for Investigating Urban Settlements" (1970) by N. I. Blazhko, S. V. Grigoryev and Y. I. Zabotin; the collections entitled "Quantitative Research Methods in Economic Geography" (1967) edited by I. M. Mayergoiz and "Mathematical Methods in Geography" (1968, 1971).

The sixties and early seventies saw the publication of several complementary series on the regional characteristics of the Soviet Union. This reflected not only a growing demand for descriptions of the country's physical geography but variations in the nature of the demand: the central and republican planning organisations, agriculture, teachers, schoolchildren and other people with an interest in nature all had different requirements as regards geographic literature. The following works have already been completed: the 15-volume Academy series "Natural Conditions and Resources of the USSR" (1963-72) and the series "Essays on Nature" in twelve volumes compiled by the "Mysl" Publishing House (1961-72). Among the series currently being published is "Zonation of the USSR for the Purpose of Agriculture". Since 1964 ten books have appeared in this series which is being compiled by teams from various universities under the general guidance of Moscow University. A geographical series issued by "Prosveshcheniye" Publishing House and the 22-volume jubilee publication "Soviet Union" (1966-72), which are intended mainly for teachers, describe the nature, population and economy of the country. The latter series gives a colourful account of the natural conditions, history, population, and economic and cultural achievements of the Soviet Union since the Revolution, and describes various regions and cities in the Union Republics and major areas of the Russian Federation.

In recent years many works have appeared on the geography of foreign countries. Particular mention should be made of the following works: "Northern Territories of Foreign Countries and Their Development" (1970) by G. A. Agranat, the collection "Geographical Problems of Socialist

Economic Integration in Europe" (1971), "Economic Geography of the Czechoslovak Socialist Republic" (1964) and "Geography of Power Engineering in the Socialist Countries of Europe" (1972) by I. M. Mayergoiz, "Fuel Resources of the Socialist Countries of Europe" (1968) by V. P. Maksakovsky, "Problems of Economic Geography in Latin America" (1969) by Y. G. Mashbits; "Population of the Socialist Countries" (1970) by Y. L. Pivovarov, "Geography of the World Economy (Leading Sectors)" (1974) by M. S. Rozin, L. I. Vasilevsky and M. B. Volf; "Economic Geography of Cuba. Economic and Territorial Problems" (1970) by B. N. Semevsky.

The nature and natural resources of foreign countries were given less systematic coverage. Some of the publications which have appeared in this period were the result of joint research between Soviet geographers and their colleagues in the socialist and developing countries. The results of a comprehensive study of Bulgaria and Rumania undertaken by Soviet geographers and geographers from these two countries were published in a number of joint monographs which appeared in the Russian, Bulgarian and Rumanian languages. Major research projects carried out in the People's Republic of China led to the publication of monographs by E. M. Murzaev (1964), M. P. Petrov (1967-68) and D. V. Panfilov (1961). Soviet scientists have cooperated in research projects, given advice to or assisted in training personnel for Vietnam, India and Pakistan. Joint research was undertaken with scientists from Czechoslovakia, Hungary, Poland and East Germany. In recent years joint research programmes involving geographers of the socialist countries have been going on within the framework of CMEA.

Exchanges with scientists from the capitalist countries, including the USA, Britain and France, now take place on a more regular basis than before. Joint research is going on in the Antarctic, and Soviet and American scientists are now cooperating in research on natural conditions and resources using space technology.

In 1974 a joint Soviet-French field symposium was held on the Alps and the Caucasus. The *National Atlas of Cuba,* which was compiled jointly by Soviet and Cuban geographers, ranked as a significant achievement.

It received the highest award of the Cuban Academy of Sciences and the USSR State Prize.

Mention should also be made of Y. A. Dmitrevsky's review of Africa's water resources, collections devoted to research on Antarctica editied by K. K. Markov (1968), a monograph on the natural resources of Canada by A. V. Antipova (1965), and collective monographs on the history of explorations of Africa (1972) and Asia, which concluded the series "Discovery of the Earth".

In the latter half of the sixties there was growing interest in theoretical and methodological problems. The desire to analyse the contemporary state of sciences and summarise their development in the fifty years since the Revolution provided an additional stimulus in this direction. The fundamental monograph "The Development of Sciences of the Earth in the USSR. 1917-1967" (Moscow, "Nauka" Publishing House, 1967), prepared by the Department of Sciences of the Earth of the USSR Academy of Sciences and the Institute for the Study of the History of Natural Sciences and Technology, represented an important summary of this kind. Besides listing the achievements in research on the earth as a whole, its crust, the upper mantle and the space around it the monograph deals comprehensively with studies on the land, the ocean and the atmosphere, to which an important contribution has been made by geographers.

It should be emphasised that all the achievements of Soviet geography spring from the work of state institutions, both scientific and applied, and that of educational establishments and scientific societies. Below we consider the structure and functioning of this network of institutions and organisations.

The Academy of Sciences' complex Institutes of Geography and Oceanology are responsible for studying the most general problems of scientific theory and research. The Institute of Geography of Siberia and the Far East and the Institute of Geography of the Far Eastern Centre (which was founded in 1971), both under the USSR Academy of Sciences, may be regarded as multi-disciplinary institutions although they also investigate specific regional problems. The following departmental institutions carry out research in their own particular fields and develop methods of research: the State Hydrological Institute, the Main Geophysical Observatory, the Arctic and Antarctic Institute, the Central Forecasting Institute, the State Oceanographic Institute, the Central Institute for Research on Geodesy, Aerial Photography and

Cartography, the Soil Institute under VASKhNIL and others. The following specialised academic institutes do comprehensive research on particular elements of nature: the Institute for the Study of Water Problems, the Institute for the Study of Lakes (Leningrad), the Institute of Limnology (Lake Baikal), the Institute of Permafrostology (Yakutia), the Institute of Forests and Timber (Krasnoyarsk), the Desert Institute (Ashkhabad), and the Institute of Atmospheric Physics.

The principal centres of research on economic geography are the Institute of Geography of the USSR Academy of Sciences and the Geographic Faculty of Moscow University, where the largest and most diverse teams of experts can be found. In addition research is carried out by the following academic organisations: the Institute of Economics of the USSR Academy of Sciences (mainly on the country's labour resources and sectors of the economy), the Institute of World Economics and International Relations, the Institutes of Africa and Latin America, and the Institute of the Economics of the World Socialist System (mainly on regional problems of a political and economic nature). Groups of experienced economic geographers are employed in the Economics and Mathematics Institute, in the Institute of Geography of Siberia and the Far East of the Academy's Siberian Department, the institutes of geography of the Academies of Sciences of the Georgian, Armenian and Azerbaijan Republics, the economic institutes under the Academies of Sciences of Kazakhstan and Estonia, the Desert Institute under the Academy of Sciences of the Turkmen Republic, in the Uzbekistan branch of SOPS, in sectors of geography of the Kazakh and Moldavian Academies of Sciences. Research on economic geography is also conducted at the geographic faculties of the universities (principally at the universities of Leningrad, Azerbaijan, Bashkiria, Yerevan, Irkutsk, Tashkent, Kazan, Latvia, Lvov, Perm, Tartu and Chernovtsy), teacher training institutes (in Leningrad, Moscow, Alma Ata), and in a number of specialised higher educational establishments (for example, in the Moscow institutes specialising in engineering and economics, the economy, geodesy, cartography, etc.). The scope of economic geographical research has widened enormously in planning institutions which now employ many qualified economic geographers—graduates of Moscow University. These include: the USSR State Planning Commission

(Gosplan), SOPS, the economic institutes under Gosplan of the Russian Federation and the Kazakh Republic, various civil engineering organisations (Gosstroi, Giprogor, etc.) and the Department of Geodesy and Cartography.

It is significant that specialised institutions, together with the geographical institutes or the departments of the Republican Academies of Sciences, the geographical faculties, departments and laboratories in the universities and teacher training institutes, comprise the basis of the regional network for the country's geographical institutions. At the same time the geographic faculties and research institutions of major universities, particularly those of Moscow and Leningrad, carry out academic research on a wide range of general problems. Republican and regional geographical research is also conducted by the corresponding institutions of the geological and hydrometeorological service, the research and experimental establishments attached to the Lenin All-Union Agricultural Academy, and the ministries of fisheries, forestry and public health. The majority of these establishments have geographical sub-departments which employ professional geographers. All geographical institutions organise permanent or temporary field expeditions and research parties, networks of observation stations, observatories and, recently, large research stations.

According to the USSR Geographical Society over 5,200 geographers and more than 90,000 qualified geography teachers were employed in the country in 1967—the fiftieth anniversary of the Revolution. The 226 departments and subsidiaries of the USSR Geographical Society, which numbered 16,000 members, played an important part in coordinating the work of geographers in different regions. In addition republican geographical societies have sprung up in many Union Republics.

The Academy's Institute of Geography not only works on major theoretical problems and develops new research methods (geochemical, geographical, spore and pollen method and others); the staff of the Institute has organised a number of joint research programmes on a national scale. This included work on compiling maps on relief, geomorphology, contemporary movements, and surface levellings; glaciological research and the compilation of glacier catalogues; the development of the typology and geography of soils; estimation of animal populations.

The Institute has had a particularly important role to play in compiling two major joint works. The first of these was the *World Atlas of Physical Geography* which the Institute prepared in conjunction with the Main Department of Geodesy and Cartography in 1964. The atlas was without precedent in the history of world geography. Fundamentally new maps with detailed explanatory texts, which covered every aspect of nature and every part of the world, were prepared especially for it. All the continents were compared and described in detail, the selection of maps of the USSR being particularly varied. Work on the maps for the atlas involved not only the departments of the Institute, but whole teams from other academic and departmental institutes.

The second joint summary work was the 15-volume series of monographs "Natural Conditions and Resources of the USSR" (Moscow, "Nauka" Publishing House, 1963-72). This series combines the features of a new summary of academic knowledge on the nature of the country and an applied work aimed at meeting the demands of national and republican planning organisations. The series contains a new section giving constructive proposals on the rational use of natural resources. Some 428 authors drawn from the ranks not only of the Academy's Institute of Geography (160 authors), but from 80 other institutions (universities, academic establishments, the Ministry of Geology, Hydrometeorological Service, etc.) contributed to the series; the work was organised by an editorial board under I. P. Gerasimov.

This form of cooperation involving attachment of authors from other organisations to the Institute is employed in the preparation of other publications, both those dealing with theory and methods and those concerned with specific regions.

The Academy's Institute of Geography is well represented on the editorial board of the journal *Proceedings of the USSR Academy of Sciences, Geographical Series* and exercises a considerable influence on the development of the country's geographical science through this medium.

Other major specialised academic or departmental institutions, which lead the field in their own branch of geography, play a similar role.

The geographical institutes or departments of the republican academies of sciences usually do research on all or most components of nature and the natural resources of their

own territory and publish regional atlases and descriptions. In addition these republican institutions often concentrate their attention on one particular subject or a group of subjects: the Institute of Geography of the Georgian Academy of Sciences, for example, is concerned with research on mountainous and humid subtropical landscapes and global anthropogenic effects on the atmosphere; the Azerbaijan Institute of Geography focuses its attention on the Caspian Sea; Academy geographers in Armenia work on problems of complex climatology, those of Kirghizia and Kazakhstan study the glaciers and rivers of the Tien Shan; in Tajikistan research is carried out on the Pamirs and the Altai, and in the Baltic Republics glacial landscapes comprise the central theme. The Turkmen Academy has its Desert Institute, and the Yakut Autonomous Republic—the Institute of Permafrostology.

The Siberian Department's Institute of Geography of Siberia and the Far East is the country's leading centre for research on taiga landscapes. The Institute is currently engaged in research into the topology of geosystems (under V. B. Sochava) using stationary observations. The Institute of Geography of the Far Eastern Centre of the USSR Academy of Sciences concentrates on predicting changes in the geographical environment. Geographers from the Ukrainian Academy are doing extensive work on geomorphology and Quaternary geology, hydrology, climatology, and on the traditional problem of the relationships between forest and steppe which is now being investigated on the basis of landscape typology.

Teams from universities, specialised institutions and teacher training establishments make a very varied contribution to the development of geographical science. In a number of universities research is carried out not just by individual scientists and departmental teams, but by specially organised laboratories or complex research institutes. Major research projects are undertaken by the staffs of the following universities: Kiev, Minsk, Baku, Tbilisi, Alma Ata, Tashkent, Voronezh, Kazan, Irkutsk, Saratov, Kharkov, Odessa, Lvov, Ashkhabad, Frunze, Riga, Vilnius and Tartu. Moscow and Leningrad Universities have made the biggest contribution to the development of Russian and Soviet geography. These two universities play the leading part in compiling the general textbooks and reference works used by

geographers throughout the country. This work is conducted on a tremendous scale. Between 1965 and 1969, for example, over 150 textbooks and other educational aids for universities and colleges (including economic geographical disciplines) were published in the Soviet Union. Most of these works are written by professors and lecturers; textbooks are rarely compiled by the staffs of research institutions.

It is worth noting that new practical and methodological disciplines and the textbooks that go with them are pioneered most frequently at Moscow and Leningrad Universities. Moscow University has an extensive and complex system of scientific sub-departments. Here various laboratories do research on particular subjects such as the North, avalanches and mud-flows, landscape science, complex map-drawing, forecasting, experimental methods, etc.; permanent expeditions such as those to the Far East and the Lake Baikal region are organised by Moscow University; research stations are maintained in the Elbrus region, in Khibiny and in the Moscow region. The University does a good deal of contract work in which many of the students are involved.

Moscow University geographers direct inter-university work on zonation for agriculture and related subjects. Lecturers from other educational establishments also come to Moscow University for retraining.

The republican universities organise curricula and compile textbooks on their own regions, some of which are published in national languages of the republic.

The Lenin Institute in Moscow and the Herzen Institute in Leningrad are the two most important teacher training colleges; their geographers compile programmes, textbooks and methodological materials for all the country's institutes, and for secondary school pupils and teachers.

The development of geographical science, the meeting of practical needs and the propagation of geographical knowledge go hand in hand with the publication of geographical literature. The following publishing houses print scientific, educational and popular geographic literature: "Nauka", "Mysl", "Prosveshcheniye", "Vysshaya Shkola", "Pedagogika", "Mir", "Progress", and specialised branches of the "Gidrometeoizdat", "Nedra", "Kolos", "Ekonomika", 'Statistika" and "Kniga" Publishing Houses; the publishing houses of Moscow and Leningrad Universities. Academy and non-Academy publishing houses in the Union Republics is-

sue literature on the geography of the regions in their national languages, whilst regional and inter-regional publishing houses do the same job in the Russian Federation. The Main Department of Geodesy and Cartography now has extensive facilities for printing and map-drawing.

Three general geographical journals—*Proceedings of the USSR Academy of Sciences, Geographical Series, Proceedings of the All-Union Geographical Society* and *Moscow University Herald, Geographical Series*—form the basis of the journal system. These are backed up by a number of specialised journals such as *Oceanology, Soil Science, Geomorphology, Water Resources, Meteorology and Hydrology, Geodesy and Cartography*, and a special journal *Geography in Schools*. Physiographical material which overlaps with other fields is published in Academy journals on geophysics, geochemistry, in various biological journals, in the popular science journal *Priroda* (Nature) and the popular magazines *Vokrug sveta* (Around the World) and *Turist* (Tourist).

A large number of geographical journals (or journals in which geography features alongside other sciences) and periodicals, transactions, notes, proceedings, etc., are published by academic institutes (for example, "Reports of the Institute of Geography of Siberia and the Far East"), universities and teacher training institutes, subsidiaries and departments of the USSR Geographical Society and the geographical societies of Union Republics.

The Institute and publishing house of the *Great Soviet Encyclopaedia* (BSE) and the All-Union Research Institute for Scientific and Technological Information (VINITI) play an important part in preparing and publishing geographical literature.

The third edition of the *Great Soviet Encyclopaedia* is currently being published. As in the previous two editions more than 10 per cent of the encyclopaedia is concerned with geographical topics. The same applies to the three editions of the *Small Soviet Encyclopaedia*. In addition the *Short Geographical Encyclopaedia* was published in five volumes between 1961 and 1966. Geographical material appears in encyclopaedias which are now published in all the republics, and in special volumes of the *Children's Encyclopaedia* concerned with the earth, the USSR and foreign countries (the third edition is now being published).

VINITI under the USSR Academy of Sciences publishes various informational materials and abstracts for scientific and practical workers, educationalists and others working in the field of geography and related disciplines. The main publication is the monthly *Geography*, which publishes over 30,000 abstracts a year from world geographical literature.

The "Results of Science" reviews which have been published since 1964 (since 1972 they have been known as the "Results of Science and Technology") analyse the literature on the main branches of geography and their development and print systematised bibliographical summaries.

The scientific and technological revolution has intensified the problems of controlling man's natural environment in the course of economic activity, protecting nature more efficiently and making better use of natural resources. This has focussed attention on theoretical research aimed at solving applied and regional problems and on the introduction of structural, systems and informational techniques necessary for predicting changes in and controlling the natural environment. Interaction between nature and technology in the course of man's economic activity results in a qualitatively new object for research. Here the need arises to study the interrelationships between the natural complexes and the objects of human activity which act permanently on them. Thus in the mid-sixties there developed research on the industrial (technological), economic, medical and biological, and social evaluation of various natural factors in the life of human society. Since the essence of this evaluation lies in comparing the properties of the natural environment and its different elements with the requirements of various aspects of life and society's activity, attention focuses on developing special methods for studying natural objects and interpreting the data obtained on them.

This end is pursued through the joint efforts of physical and economic geographers, philosophers, sociologists, technologists, etc.

In recent years physical and economic geographers from the Institute of Geography of the USSR Academy of Sciences have in cooperation with operational organisations developed research on recreational geography which sets out to study the various forms of recreation. The Institute has done a good deal of work on this subject and pioneered the develop-

ment and substantiation of a new concept—territorial and recreational systems (TRS).

The need to safeguard the health of the working population, which involved preventing illness by improving the environment, and the population's living, working and leisure conditions in traditional centres of population and newly-developed areas, gave rise to research on medical geography, first at the Institute of Geography of Siberia and the Far East and subsequently at the Institute of Geography of the USSR Academy of Sciences. Medical geographers study the way in which individual elements of the environment influence the health of the population and the outbreak and spreading of disease, and develop methods for assessing the natural and social conditions in which diseases appear.

The practical needs of society in the context of the scientific and technological revolution and the development of sciences of the earth resulted in a constructive-transformational trend in geographical research, which has developed particularly rapidly at the Academy's Institute of Geography. As Academician I. P. Gerasimov has often pointed out (1966, 1967 and others), its main purpose is to formulate the theoretical principles of planned development of the natural environment so as to make effective use of and renew natural resources; to make predictions of change in the natural environment and develop the scientific principles in which new industrial-territorial complexes will be formed and the old ones reconstructed in a new natural situation. This trend is also concerned with problems of territorial distribution of economic enterprises and population. In this context it is vital to elaborate the general theory of purposeful development of the environment from the contemporary conceptions of individual geographical disciplines such as climatology, hydrology, geomorphology, soil science and biogeography.

Man's increasing pressure on nature leads to the formation of new natural-technological complexes in it where natural elements combine organically with technological ones. The need to forecast indirect and long-term environmental changes caused by technology has placed contemporary landscape research on a new level and necessitated the wide application in it, as well as in other fields of geographical research (for example, the ecology of man, urbanisation, recreational and medical geography), of systems analysis, mathematic modelling and other modern research methods.

Constructive problems include multi-purpose regional projects aimed at developing the environment of large areas, such as the Russian Plain and Western Siberia, the development of irrigation in the area of the Kara Kum Canal and the rechannelling of water from the Siberian rivers to Central Asia; they also include theoretical problems involved in the substantiation of new trends related, for example, to cycles of natural resources or recreational geography. Other research concentrates on the anthropogenic eutrophication of water bodies, the productivity of ecosystems of the central forest-steppe, the natural-technological systems and nature reserves. A number of studies focuses on one of the most urgent problems of the modern age—the interaction of man, society and the environment. Recently the task of protecting the environment of present and future generations of human society has come very much to the fore. And although this is an inter-disciplinary problem, Soviet constructive geography has good reason to be among those who initiate and organise research on it. The Academy's Institute of Geography has already done a great deal in this direction compiling the joint monographs "Resources of the Biosphere in the USSR" ("Nauka" Publishing House, 1971) and "Man, Society and the Environment. Geographical Aspects of the Use of Natural Resources and the Protection of the Environment" ("Mysl" Publishing House, 1973). The latter is the first work to state the position of Soviet geographers on a wide range of questions connected with this problem.

The discovery and assessment of natural resources, the study of the influence of industrial production on the environment, the elaboration of the theoretical and methodological principles underlying this influence, the formulation of the general theory of the purposeful development of the environment and the creation of the most effective natural-technological systems—these are the most important trends in geographical research on the interaction between man, society and the environment.

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